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VOL. CXXXIX.—No. 3612] LONDON: FRIDAY EVENING, MARCH 20, 1925 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—
1. MATERIALS and FITTINGS for RAILWAY FREIGHT VANS.
2. LEAD SQUIRTING PRESSES with ELECTRICALLY DRIVEN HYDRAULIC PUMPS.
3. WHEELS and AXLES.

Tenders due on the 7th April, 1925.
Tender forms obtainable from above. 8695

Ministry of Transport. ROADS DEPARTMENT.
APPLICATIONS are INVITED for a TEMPORARY APPOINTMENT as ASSISTANT ENGINEER for Road Work in the London area on the range of salary £300/£400 per annum, inclusive, according to experience and qualifications.
Candidates should be practical and experienced men with a knowledge of local administration and of modern road and bridge construction. Preference will be given to men who have served in His Majesty's Forces.
Applications should be made immediately in writing to the ESTABLISHMENT OFFICER, Ministry of Transport, 6, Whitehall-gardens, S.W. 1, stating age, qualifications, experience, and references. 8687

Meter Tester and Repairer REQUIRED for duty in Works and Buildings Department, Air Ministry, Iraq. Applicants must be ex-Service, should preferably be unmarried and under 35 years of age, must have had not less than 5 years' workshop experience of the manufacture and repair of all classes of D.C. and A.C. electricity meters, together with outside experience of locating faults and effecting adjustments. Salary £450 per annum inclusive.
Applications should be addressed to the SECRETARY, Air Ministry (W.B. 5), Kingsway, W.C. 2. 8679

Northampton Polytechnic INSTITUTE,
ST. JOHN-STREET, E.C. 1.
A SPECIAL COURSE of
SIX LECTURES
ON
"THE METALLOGRAPHY AND HEAT TREATMENT OF IRON AND STEEL,"
will be given on
THURSDAY EVENINGS, at 7 p.m., by
Mr. R. GENDERS, M.B.E., B. Met.,
commencing on March 19, 1925, as follows :—
March 19.—Wrought Iron and Shear Steel.
March 26.—Properties and Heat Treatment of Carbon Steels.
April 2.—Special Purpose Steels.
April 16.—Tool Steels.
April 23.—Defects in Steels.
April 30.—Cast and Malleable Cast Iron.
These lectures are open to the public without fee.
S. C. LAWS,
8598 Principal.

Northampton Polytechnic INSTITUTE,
CLERKENWELL, LONDON, E.C. 1.
HEAD OF THE ELECTRICAL ENGINEERING DEPARTMENT.
The Governing Body invite APPLICATIONS for the VACANT POST of HEAD of the ELECTRICAL ENGINEERING DEPARTMENT.
The salary scale at present applicable to the post is £700-25-900 (less an abatement of 5 per cent.). The period during which the present scale (and abatement) is operative expires on March 31st, 1925, when some revision may take place following an award of the arbitrator appointed in connection with the Joint Standing Committee on Teachers' Salaries.
The post is governed by the provisions of the Teachers (Superannuation) Acts.
Further particulars and forms of application may be had on application to the undersigned, to whom applications should be forwarded not later than April 18th.
S. C. LAWS, M.A., M.Sc.,
8617 Principal.

NOTICE.
An Adjudication has been proclaimed by the GREEK GOVERNMENT, which will take place in Athens at the offices of the Engineering Department of the Ministry of War on Saturday, 25th April, 1925, between Ten and Twelve o'clock, for the SUPPLY of STEEL FRAMES for the ERECTION of 10 KITCHENS, 34 STABLES, and 5 ANIMALS' CONVALESCENT HOMES. Conditions and particulars of this Adjudication may be obtained at the GREEK LEGATION, 51, Upper Brook-street, W. 1.
10th March, 1925. 8674

Borough of Bridlington. EXTENSIONS TO ELECTRICITY WORKS.
The Bridlington Borough Council invite TENDERS for the SUPPLY and ERECTION in their Electricity Works at Brett-street, Bridlington, of the following :—
SPECIFICATION NO. 2. — MECHANICAL STOKERS, GRATES, FORCED DRAUGHT PLANT, COAL ELEVATORS, HOPPERS, and SUPERHEATERS for EXISTING LANCASHIRE BOILERS.
A copy of the specification can be seen at and obtained from the offices of Messrs. Kennedy and Donkin, 8, Broadway, Westminster, S.W. 1, on and after Monday, the 16th March, upon payment of a deposit of £1 1s. (cheque, postal order or money order). An additional copy of the specification can be obtained upon payment of a deposit of 10s. 6d. These deposits will be returned after the receipt of a bona fide Tender and on the return of the specification.
Tenders, on the prescribed form, enclosed in sealed envelopes, and addressed on the outside "Extensions to Electricity Works, Tender to Specification No. 2," must be delivered at the office of the undersigned not later than Monday, the 30th March, 1925.
The Council do not bind themselves to accept the lowest or any Tender.
GEORGE MELVIN,
Town Clerk.
Town Hall, Bridlington,
March, 1925. 8652

The Engineer

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The British Steam Railway Locomotive from 1825 to 1924—No. 12.
The Navy Estimates.
Dock Equipment on the Clyde—No. IV.
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22,000 Volt Electric Locomotives.
Institute of Metals—Annual Meeting.
Helium and Caisson Disease.
The Marine and Small Craft Exhibition.

PUBLIC NOTICES

Edinburgh Corporation Electricity Supply.
The Lord Provost, Magistrates and Council invite TENDERS for the following :—
SPECIFICATION NO. 65.
STEAM, FEED and CIRCULATING PIPE WORK with VALVES for Extension Turbine and Boiler Plant.
Specifications, drawings and forms of Tender for the above may be obtained from the Engineer and Manager, Dewar-place, Edinburgh, on and after March 24th on payment of a deposit of £2 2s. An additional copy of the specification may be obtained on payment of a deposit of £1 1s. These deposits will be returned on the receipt of a bona fide Tender and on the return of the specifications.
Tenders, on the prescribed forms, must reach the undersigned under sealed cover and endorsed "Tender for Pipe Work," not later than first post on April 10th, 1925.
The Council do not bind themselves to accept the lowest or any Tender.
A. GRIERSON, S.S.C.,
Town Clerk.
City Chambers, Edinburgh,
19th March, 1925. 8672

Edinburgh Corporation Electricity Supply.
The Edinburgh Corporation is prepared to receive OFFERS for the following BOILERS, GENERATING PLANT, PUMPS, &c., situated at their Dewar-place, McDonald-road, and Leith Generating Stations :—
LEITH STATION.
Three Hand-fired Lancashire Boilers, each rated at 6000 lb. per hour, 160 lb. gauge pressure.
Two Babcock and Wilcox Boilers, each rated at 22,000 lb. per hour, with chain grate stokers, 160 lb. gauge pressure.
One Greens' Economiser of 480 11ft. tubes.
Two Howden-Crompton D.C. Generating Sets, each 330 K.W., 460/550 volts, shunt or compound, non-condensing.
One Metropolitan-Vickers D.C. Turbo-Generator, 500 K.W., 460/550 volts, shunt or compound, complete with condensing plant, and cooling tower of 96,000 gallons per hour.
Two 44in. Carruthers' Compound Feed Pumps.
Two Exhaust Steam Feed-water Heaters.
McDONALD-ROAD STATION.
Nineteen Dry-back Marine Boilers, 160 lb. gauge pressure, each rated at 10,000 lb. per hour, fitted with mechanical stokers.
Seven Willans/Mather and Platt or Siemens D.C. Generators, each 780 K.W., 230 r.p.m., 460/520 volts.
Two Fraser and Chalmers/Brown-Boveri Exhaust Steam D.C. Turbo-generators, each 1200 K.W., 1250 r.p.m., complete with condensers and air pumps.
One Fraser and Chalmers/Siemens 6-Phase Mixed Pressure Turbo-generator, 1500 K.W., 374/410 volts, 3000 r.p.m., 50 periods, complete with condensers and air pumps.
One Condenser with Air Pump and Circulating Pump, suitable for a 1500 K.W. set, complete with 25 H.P. and 85 H.P. D.C., 500-volt motors.
All the above condensers are designed for inlet water at 70 deg. F. and an outlet temperature not exceeding 90 deg. F.
DEWAR-PLACE STATION.
Two Willans/Siemens D.C. Generators, each 225 K.W., 230 volts, non-condensing.
One Willans/Ferranti Single-phase Alternator, 150 K.W., 2000 volts, non-condensing.
The plant can be inspected any day between 9 a.m. and 5 p.m. by appointment.
Offers for any part or all of this plant must be sent to the undersigned not later than first post on Monday, April 6th, 1925, and endorsed "Offers for Electricity Plant."
ANDREW GRIERSON, S.S.C.,
Town Clerk.
City Chambers, Edinburgh,
13th March, 1925. 8620

PUBLIC NOTICES

Bombay, Baroda and Central INDIA RAILWAY COMPANY.
The Directors are prepared to receive up to Noon on Friday, 3rd April, TENDERS for the SUPPLY of :—
1. SCREW COUPLINGS.
2. WHEELS AND AXLES FOR CARRIAGES AND WAGONS.
3. STEEL MATERIAL (PLATES, CHANNELS, ANGLES, &c.).
4. AXLES FOR CARRIAGES AND WAGONS.
5. TYRES FOR CARRIAGES AND WAGONS.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 20s. each for Nos. 1, 2, and 3, and 10s. each for Nos. 4 and 5 (which will not be returned).
The Directors do not bind themselves to accept the lowest or any Tender.
S. G. S. YOUNG,
Secretary.
Offices : 91, Petty France, Westminster, S.W. 1. 8681

Great Northern Railway (Ireland).
TO STEEL WORK CONTRACTORS.
The Directors are prepared to receive TENDERS for the SUPPLY and ERECTION of a SMALL STEEL AQUEDUCT between Newtownstewart and Victoria Bridge.
The drawing and specification may be inspected at the Engineer's Offices, Dublin and Belfast, and copies of same, together with bill of quantities and form of Tender may be obtained from the undersigned on payment of Two Guineas, which will be refunded on receipt of a bona fide Tender.
Tenders, made out on forms supplied by the Company, should be delivered under sealed cover, endorsed "Tender for Aqueduct," not later than 10 a.m. on Monday, March 23rd.
The Directors do not bind themselves to accept the lowest or any Tender.
J. B. STEPHENS,
Secretary.
Amiens-street Station, Dublin,
10th March, 1925. 8656

Kidderminster Rural District Council.
WOLVERLEY WATER SUPPLY.
TO OIL ENGINE AND PUMP MANUFACTURERS.
The above Council invite TENDERS for the SUPPLY and ERECTION at Cookley Bridge, near Kidderminster, of TWO OIL ENGINES and BELT-DRIVEN TREBLE-RAM PUMPS of a capacity at the rate of 4000 gallons per hour under a head of 350ft.
Forms of Tender, general conditions, specification and drawings may be obtained from the Engineers, Messrs. Fiddian and Deeley, 13, Church-street, Stourbridge, on and after Monday, the 23rd inst., on payment of a deposit of Two Guineas, to be returned upon receipt of a bona fide Tender together with all incidental papers supplied therewith.
Sealed Tenders, endorsed "Tender for Oil Engines and Pumps," to be sent to the undersigned not later than Noon, Monday, the 6th prox.
The Council do not bind themselves to accept the lowest or any Tender.
F. E. BURCHER,
Clerk to the Council.
Bank Buildings, Kidderminster,
14th March, 1925. 8657

The Great Indian Peninsula RAILWAY COMPANY, 48, Copthall-avenue, London, E.C. 2, invite TENDERS for :—
1. CARRIAGE UNDERFRAMES with 4-WHEEL BOGIES ..... } Fee £1
CARRIAGE UNDERFRAMES with 6-WHEEL BOGIES ..... }
Tenders are due by 11 a.m. on 7th April, 1925. Tender forms obtainable at above address. Fees not returnable. 8680

PUBLIC NOTICES

PATENTS AND DESIGNS ACTS, 1907 AND 1919.
Notice is Hereby Given that FREDERICK MARTEN HALE, of Furzedene, Kinnaird-avenue, Bromley, in the County of Kent, gentleman, the Patentee, SEEKS LEAVE to AMEND the SPECIFICATION of LETTERS PATENT No. 22,601 of 1914, granted to him for "Improvements in or pertaining to Explosive Shells or Similar Bodies."
Particulars of the proposed Amendment were set forth in the Illustrated Official Journal (Patents) issued on the 18th March, 1925.
Any person, or persons, may give notice of Opposition to the Amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, London, W.C. 2, within one calendar month from the date of the said Journal.
W. TEMPLE FRANKS,
8688 Comptroller-General.

The Madras and Southern Mahratta Railway Company, Limited.
The Directors are prepared to receive TENDERS for :—
(I.) 296 PAIRS WHEELS and AXLES, with DISC CENTRES and SANDBERG SORBITIC TYRES, for Four-wheeled Covered and Open Goods Wagons (METRE GAUGE) ;
(II.) METALS (comprising Antimony, Brass Sheets and Wire, Copper Ingots, Plates, Sheets, Wire, and Tubing, Lead Piping and Sheets, and Zinc Sheets),
in accordance with the specifications, which may be seen at the offices of the Company. The charge for each of the specifications is One Guinea (£1 1s.), which will not be returned.
Tenders must be sent in, addressed to the SECRETARY, not later than 2 p.m. on Tuesday, 7th April, 1925, and marked "Tenders for Wheels and Axles," or as the case may be.
The Directors do not bind themselves to accept the lowest or any Tender.
Company's Offices :
25, Buckingham Palace-road, S.W. 1.
13th March, 1925. 8638

Tyne Improvement Commission. TIMBER JETTY AND STEEL SHEET PILING IN HOWDON YARD BAY.
The Tyne Improvement Commissioners are prepared to receive TENDERS for the CONSTRUCTION of a TIMBER JETTY and STEEL SHEET PILING at their Engineering Yard, Howdon-on-Tyne.
Copies of the form of Tender, conditions of contract, specification and drawing may be obtained on application to the undersigned on payment of a deposit of £2 2s., which will be returned on receipt of a bona fide Tender.
Tenders, in sealed envelopes, endorsed on the cover "Tender for Timber Jetty and Steel Sheet Piling," must be addressed to "The Chairman, Dredging and River Works Committee," and delivered at the undermentioned offices not later than Noon on Monday, the 6th proximo.
The Commissioners do not bind themselves to accept the lowest or any Tender.
By Order,
ALBERT BLACKLOCK,
Secretary.
Tyne Improvement Commission Offices,
Bewick-street, Newcastle-upon-Tyne,
18th March, 1925. 8673

Bombay, Baroda and Central INDIA RAILWAY.
ASSISTANT SIGNAL ENGINEER.
The Directors are prepared to receive APPLICATIONS (by letter only) from properly qualified candidates for APPOINTMENT as ASSISTANT SIGNAL ENGINEER on the above Railway.
Candidates should be between 25 and 30 years of age and must have had a public school or good secondary school education, and a technical education in mechanical and electrical engineering at a recognised Engineering College. They should have served a full course in a Railway Signalling Workshop and should have a thorough knowledge of modern railway signalling practice, including the preparation of signalling schemes, and the installation and maintenance of same. Preference will be given to a candidate with experience in the manufacture and maintenance of single and double-line block instruments.
COMMENCING SALARY.—Rs. 450 per calendar month, or such higher salary as may be justified by age and qualifications.
TERMS.—A three years' agreement in the first instance, first-class free passage to India and home again, subject to satisfactory termination of services.
The selected candidate will be required to pass a strict medical examination by the Company's Consulting Physician before appointment.
Applications (by letter only), giving age, whether married or single, and full details of general and technical education, together with a statement (with dates) of candidate's career, in chronological order, and showing in what departments training and subsequent experience has been obtained, and class of work employed upon, should be addressed to the undersigned not later than the 3rd April, 1925.
S. G. S. YOUNG,
Secretary.
Offices : The White Mansion,
91, Petty France, Westminster, S.W. 1,
13th March, 1925. 8663

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PUBLIC NOTICES

Burma Railways.

THREE ASSISTANT ENGINEERS.

The Directors are prepared to receive APPLICATIONS (by letter only) from properly qualified candidates for APPOINTMENT as ASSISTANT ENGINEERS in Burma.

Applicants must be between 22 and 28 years of age (bachelors preferred) and be active and of good physique. They must have had at least three years' training in a recognised Engineering College and hold an Engineering Degree or have passed the A.M. Inst. C.E. Examination, and have had practical experience with a railway company or on public works of not less than one year.

SALARY.—Rs. 550 to commence, rising by annual increments of Rs. 50 to Rs. 1100 per calendar month.

TERMS.—A three years' agreement in the first instance, with first-class free passage to Burma and home again on satisfactory termination of services.

The selected candidate will be required to pass a strict medical exsmination by the Company's Consulting Physician before final appointment.

Applications, giving all the particulars called for above, and showing candidate's career in chronological order (with dates), should be addressed to the undersigned not later than the 2nd April, 1925.

SECRETARY.

199, Gresham House,
Old Broad-street, London, E.C. 2 8653

County of London.

The London County Council invites APPLICATIONS for the POSITION of POWER STATION ENGINEER at its Greenwich Power Station in its Tramways Department.

The salary will be £600 a year, rising by annual increments of £50 to a maximum of £700 a year. The salaries mentioned are based on pre-war conditions and are subject at present to temporary additions on the Civil Service scale, fluctuating according to the cost of living. The total commencing remuneration at the present time on the existing basis is £801 10s. 7d. a year.

Candidates must be fully trained and qualified engineers and have held a responsible position in a large generating station.

Candidates not already in the Council's service must be not less than 35 and not more than 50 years of age on the latest day for receiving applications. Preference will be given to candidates who served or attempted to serve with H.M. Forces during the Great War.

Apply for forms (containing full details) to the Clerk of the Council, The County Hall, Westminster Bridge, S.E. 1 (stamped addressed foolscap envelope necessary). Forms must be returned so as to be received not later than Twelve o'clock Noon on Tuesday, 14th April, 1925. Canvassing disqualifies.

MONTAGU H. COX,
8630 Clerk of the London County Council.

County of London Electric

SUPPLY COMPANY.
BARKING POWER STATION.
COMBUSTION ENGINEERS.

APPLICATIONS are INVITED from practical engineers who have a thorough knowledge of the combustion of coal and the efficient generation of steam. Applicants must also have had previous experience in the handling and operation of large modern boiler units. The salary offered will depend on experience.—Replies, stating particulars of experience and age, to the RESIDENT ENGINEER, Creekmouth, Barking, Essex. 8682

The South Metropolitan Gas

COMPANY has a

VACANCY FOR AN ENGINEER

with wide experience in the design, construction, erection and repair of Gasholders, Retort and other Manufacturing Plant and Structures of the kind used in Gasworks and Coke Oven Recovery.

Applications, giving age, full particulars of qualifications, experience, military service, and salary required, should be made in writing to the undersigned before 31st inst.

By Order,
FRANK DAY,
Secretary.

709, Old Kent-road,
London, S.E. 15.
14th March, 1925. 8639

"Works Training" Centre, DOVER.

WANTED IMMEDIATELY TWO or THREE INSTRUCTORS in WOODWORK and METAL-WORK respectively. Applicants should have good workshop experience, with ability to teach, and a knowledge of and sympathy with adolescent boys.

The Centre is to be run experimentally in the first instance for the Summer and the Autumn Terms (April to December 1925). If successful, the Institution may be continued and permanent appointments be made.

Applications, stating age, qualifications, experience, and salary required, should be sent, together with copies of three recent testimonials, not later than March 30th, to F. WHITEHOUSE, M.A. (Hon. Director, "Works Training" Centre), County School for Boys, Frith-road, Dover. 8614

SITUATIONS OPEN

WANTED, ASSISTANT WORKS MANAGER in Engineering Works; must understand management of men and up-to-date machinery; also producing work on most economical lines. State age, salary required.—Address, 8643, The Engineer Office. 8643 A

WANTED for Machine Tool Works, West Riding of Yorks., GENERAL MANAGER; capacity of works, normally 80-100 hands; old-established firm, with good reputation for its products. Splendid opportunity for man of real managerial ability, capable of organising for good sales and quality output at competitive prices.

Applications, which will be treated in strictest confidence, giving full particulars, to WHITFIELD, Solicitor, Arundel-place, Scarborough. P460 A

ADVERTISING MANAGER. — ENGINEERING FIRM in Midlands has VACANCY for an experienced ASSISTANT. Must be thoroughly conversant with all branches of publicity work and able to take charge copy and catalogue lay-out. Good opening and permanency for right man. State experience, age, and salary required.—Address, 8677, The Engineer Office. 8677 A

ASSISTANT ENGINEERS REQUIRED for Chief Engineer's Department of important Argentine Railway. Age 25-32. Applicants should have had previous railway experience, either on construction or maintenance, and should have qualified or be qualifying for A.M. Inst. C.E. Three years' engagement at salary of £450, £500, and £550 plus £50 when working knowledge of Spanish has been acquired. Free passage.—Please give details of education, training, experience, age, &c., with copies (only) of testimonials, to Box Q.R.D., c/o Davies and Co., 95, Bishopsgate, E.C. 8671 A

CEMENT COMPANY MANAGEMENT ASSISTANT, with Practical, Mechanical and Electrical Engineering, but not necessarily Cement, Experience; Science Degree preferred. State age (between 30 and 40), experience, also salary required.—Address, 8645, The Engineer Office. 8645 A

CONSTRUCTIONAL ENGINEERS in London REQUIRE SERVICES of an ASSISTANT to WORKS FOREMAN.—Address, stating age, experience and salary required, P399, The Engineer Office. P399 A

CHIEF ENGINEER SALESMAN REQUIRED, to Take Charge of Sales Department of Large Firm supplying Centrifugal Liquid Purifiers. Unique opportunity for suitable man, who must have initiative, organising ability, extensive sales experience, and preferably some knowledge of centrifugals. State age and salary required and give full particulars of qualifications and experience.—Address, 8599, The Engineer Office. 8599 A

CORRESPONDENCE is INVITED from GENTLEMEN having opportunities amongst their colleagues to INTRODUCE INSURANCES for Personal Accident and Illness. A liberal commission will be paid and every assistance rendered by the company's officials.—Address, in confidence, 8644, The Engineer Office. 8644 A

ESTIMATOR REQUIRED for Fixing Prices of Machining, Fitting and Assembling in Engineering Works near London.—Write, stating age, experience and where obtained, and salary required, Box 652, Sells Advertising Offices, Fleet-street, E.C. 4. 8649 A

ESTIMATOR, Able to Make Up Structural Steel Estimates from outline drawings, combining experience of Mechanical Handling Plants for Coal, Ore, &c. Only experienced men need apply. State age, experience, and salary required.—Address, 8684, The Engineer Office. 8684 A

FIRST-CLASS REPRESENTATIVE REQUIRED by London Brassfoundry specialising in gun-metal and phosphor-bronze castings. Liberal terms to right man. Applicants must state approximate turnover and ground covered last two years.—Apply by letter only, THE TEMPLUS METAL CO., Ltd., 16, Hazelville-road, London, N. 19. 8685 A

MECHANICAL RUBBER GOODS REPRESENTATIVE WANTED, with connection amongst the leading mining and manufacturing industries that use belting hose and packing.

Must have sufficient engineering knowledge to be capable of making recommendations to engineers for proper plant equipment.

Write, with full particulars of qualifications and past experience, to 8690, The Engineer Office. 8690 A

PRODUCER GAS PLANT.—WORKING CHARGE HAND, having experience in the operation of By-product Producer Gas Plant, REQUIRED for new plant in Edinburgh district. Applicants must be under 40 years of age. State details of previous experience, wage required, &c.—Address, 8676, The Engineer Office. 8676 A

REINFORCED CONCRETE ENGINEER.—A Leading Firm of Reinforced Concrete Designers REQUIRE a capable and energetic ENGINEER, to Take Charge of a portion of the Drawing-office Staff. Specialist in design, experience, and executive ability essential.—Applications, giving full tabulated summary of qualifications and experience and stating age and salary required, will be treated in strict confidence, and should be addressed in the first instance to 8678, The Engineer Office. 8678 A

RESIDENT MECHANICAL ENGINEER, with Practical Experience of Electrical Machinery, REQUIRED at the Holloway Sanatorium, Virginia Water, Surrey.—Applications, accompanied by testimonials, to be addressed to the MEDICAL SUPERINTENDENT. 8642 A

SALES CORRESPONDENT, 25/30 Years of Age, with experience in dealing with correspondence relative to Heavy Machinery and Transport.—Write, giving full particulars of past experience, copies of testimonials, and salary required. Preference given to man not at present employed.—Ref. "S/C." Russell Press, Clun House, Surrey-street, London, W.C. 2. 8670 A

TRAINED ENGINEER, Mechanical and Electrical, REQUIRED to go to Malaya; public school, single, preferred; minimum age, 27; maximum, 32. Must be essentially a practical man, with some commercial experience. Salary about £600.—Address, P401, The Engineer Office. P401 A

VACANCY for METALLURGICAL CHEMIST of exceptional qualifications and experience for Blast-furnaces and Steel Melting Shop, and to assist Melting Shop Manager, in Midlands.—Address, giving fullest particulars, 8646, The Engineer Office. 8646 A

WANTED, JUNIOR DRAUGHTSMAN, Preferably with experience Crushing, Grinding and Conveying Plant. State details of experience, age, and salary.—Address, P427, The Engineer Office. P427 A

CENTRAL HEATING AND HOT WATER SUPPLIES.—Smart Young DRAUGHTSMAN WANTED AT ONCE, experienced in laying out large installations. Good prospects. State age, experience, and salary.—Address, P432, The Engineer Office. P432 A

DRAUGHTSMAN for London District, Used to Constructional Ironwork and Tank Work. State fully experience and wages required.—Address, P420, The Engineer Office. P420 A

DRAUGHTSMAN REQUIRED, Accustomed to Designing, Detailing, Structural Steelwork for Factory Buildings, &c.; N.W. London suburb.—Address, stating age, experience, salary required, P405, The Engineer Office. P405 A

DRAUGHTSMAN REQUIRED by Engineering Firm in North of Scotland for Mechanical Handling Plants for Coal and other Materials; only men with complete knowledge of design and first-class experience need apply.—Address, stating age, full particulars of experience and salary required, 8633, The Engineer Office. 8633 A

DRAUGHTSMAN, SENIOR, with First-class Experience on Power or Instrument Transformer Work.—Address, stating age, qualifications, and salary required, and earliest date could commence, 8550, The Engineer Office. 8550 A

DRAUGHTSMAN, Skilled in Design and Lay-out of Mechanical Handling Plants for Ore and Coal. Men without actual experience need not apply. State age, experience, and salary required.—Address, 8683, The Engineer Office. 8683 A

DRAUGHTSMEN WANTED by Firm of Westminster Engineers. Must have thorough knowledge and experience of works in connection with Dock, Harbour and large Public Works Contracts.—Apply, giving full particulars of age, experience, and salary required, to Box 647, c/o Brown's, Tothill-street, Westminster, S.W. 1. 8561 A

DRAUGHTSMAN WANTED by Firm in the Midlands manufacturing Municipal Vehicles. Applicants should state age, experience, and salary required, and enclose copies of references.—Address, 8539, The Engineer Office. 8539 A

DRAUGHTSMEN WANTED by West of England Firm manufacturing High-class Small Machinery, chiefly relating to Printing and Cardboard Box Manufacture. Previous experience in this class of work not essential, but applicants will be required to give evidence of ingenuity and practical engineering ability. Applications, which should give age (preferably 25-30), training and salary desired, will be treated in confidence.—Address, 8596, The Engineer Office. 8596 A

DRAUGHTSMAN, with Experience in Design and Supervision of up-to-date Hot Water and Steam Apparatus.—Apply, stating age, experience and salary required, HENRY HOPE and SONS, Ltd., Halford Works, Birmingham. 8661 A

EXPERIENCED TRACER REQUIRED.—Please state age, salary required, together with sample of work, to Box 892, T. B. Browne's Advertising Offices, 163, Queen Victoria-street, E.C. 4. 8694 A

ONE or TWO STRUCTURAL DRAUGHTSMEN WANTED in London; must have experience of the preparation of shop details for Steel-frame Buildings. State age, previous experience, and salary expected.—Address, 8691, The Engineer Office. 8691 A

SITUATIONS WANTED

AN ENGINEER,

Specialist in Aerial Ropeways, Chain and Rope Haulage, Ship Loading Plants, Etc.,

with rich Continental experience obtained on some of the largest plants in the World, OPEN TO CONSIDER PROPOSITION from established manufacturers or firms contemplating the manufacture of such plant.

Advertiser's experience includes estimating, negotiating orders, surveying and route selection, designing in steel and wood, erection and maintenance, and is further a well-known and recognised authority on such specialities. Will act as Consultant or otherwise.—Address, P398, The Engineer Office.

P398 B

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For continuation of Small Advertisements see page 3.

A Seven-Day Journal

A New London Railway?

When the Southern Railway's electrification scheme is completed early next year, the company will have in operation 650 miles of electrified track. The electrification scheme, the company claims, is the biggest thing of its kind ever undertaken, and the service it will provide will enable the company to claim ownership of the world's greatest suburban railway. In the course of some remarks made in the course of an inspection last Friday of the works at Ashford and Brighton, Sir Herbert Walker, the general manager, stated that the directors were already anticipating the time—probably five years hence—when the increased facilities provided by the electrification schemes now in hand would be absorbed by the anticipated increase in the traffic. He remarked that the difficulty could not be met by enlarging the terminal stations, and that the management was considering various alternative schemes, the nature of which, however, he could not then disclose. According to a trustworthy contemporary, one of the schemes under examination is believed to be the construction of an inner London railway linking up the existing Southern stations at London Bridge, Cannon-street, Charing Cross, Waterloo and Victoria. The line would be largely underground, and would involve at least two under-river crossings. Its object would be to convert the present termini into through stations, so that incoming trains would not require to reverse at them but complete the circle in one direction and pass out on to the suburban lines. The scheme is a grandiose one, and would clearly involve a vast expenditure, not only on the construction of the new works required but in adapting the existing works to suit it. Indeed, when we consider the levels of the existing stations it seems very improbable that it will ever be carried out.

A Reparations Dilemma.

The placing of an order for 4000 wagons in Germany on behalf of the French railway companies has revealed the danger that is likely to arise from the payment of reparations in goods that can be manufactured in France. When the Government decided to require Germany to deliver the wagons in accordance with the terms of the Wiesbaden agreement, it was understood that a similar quantity of rolling stock would be ordered from French builders. These builders now complain that the orders distributed amongst them are wholly insufficient, and that in the course of a few months they will again find themselves in a precarious situation, while wagons are being sent into France from Germany. The same thing will necessarily befall other industries in the event of manufactured goods being obtained from Germany by way of reparations. The French union of wagon builders, therefore, suggests that Germany should be required to supply such products as coal, which France is obliged to import at considerable cost. This alteration would, it is urged, serve the double purpose of saving the huge sums paid for British coal and of obtaining reparations in a way that would not prejudice French industries. The weakness of the plan lies in the refusal of Germany to deliver more than the specified minimum quantity of fuel.

The Barking Power Station.

At the thirty-first annual general meeting of the County of London Electric Supply Company, Ld., Sir Harry Renwick, the chairman and managing director, gave some brief particulars of the new Barking power station, which is to be opened by the King on May 19th. At present the equipment consists of four turbo-generators, ten water-tube boilers and two reheaters. There are two 35,000-kilowatt and two 15,000-kilowatt units. The boiler-house is to be under the control of a combustion engineer, who will be responsible for the efficient operation of the steam-raising plant. The coal and ash-handling plant is completely automatic, and coal can be discharged either directly from steamers into the boiler-house bunkers or on to a space between the jetty and power-house, where it can be stored. There is also an emergency coal store which, together with that just mentioned, will enable sufficient coal to be kept in readiness to meet any case of emergency. Coal can also be delivered to the station by the Midland Railway, which has a siding on the station site. Thirty-three thousand-volt cables will connect up the station with three new sub-stations in the London area.

Expanding French Exports.

France is one of the few countries whose returns of foreign trade show consistently increasing exports over imports, and, what is of even more importance from the point of view of the "balance of trade," the returns show that manufactured goods are responsible for the great bulk of the export totals. Until a few months ago there was an undeniable prosperity in the manufacturing industries, and even now, when the monetary stringency has undermined the foundation, the situation is by no means unsatisfactory, although fraught with a good deal of uncertainty as to the future. Nevertheless, the trade returns imply a greater industrial prosperity than really exists, and the considerable increase in the exports of manufactured goods can only be attributed to essentially French productions, outside engineering, which have particularly benefited from the monetary depreciation. Manufactured goods also include iron and steel, which are being exported in huge quantities from the North-Eastern departments and Lorraine. The export business has been elaborately organised, and even the Germans complain of the low prices at which French iron is being offered, although it may be doubted whether the complaints are serious. It is, nevertheless, obvious that the competition of French iron and steel will become an increasingly important factor in foreign markets in the future.

Aircraft in Our New Battleships.

Advocates of a strong navy for the United States continue to make a great deal of capital out of the secrecy which surrounds all new construction in this country. Their latest suggestion is that Great Britain is trying to circumvent the Washington Treaty—which restricts the displacement of aircraft carriers—by making our new battleships, the Nelson and Rodney, combine the functions of capital ships and aircraft carriers. Each of these vessels, they assert, will be equipped with thirty to fifty aeroplanes, and in order to provide deck space for landing and taking-off purposes the heavy gun turrets are to be placed forward of the bridge. It is hardly necessary to point out that a ship of 35,000 tons displacement, mounting a main armament reported to consist of nine 16in. guns, besides numerous auxiliary weapons, and fitted with the massive armour protection which war experience has shown to be essential, could not possibly be provided with the storage capacity for a large flock of aeroplanes. Even in vessels expressly built as aircraft carriers the complement of machines is very limited. The Argus, of 14,500 tons, is able to accommodate only 20 aircraft; and the Hermes, in which every foot of available space is devoted to the carriage and manipulation of aeroplanes, can only accommodate the same number. It is, therefore, physically impossible that the new battleships should carry more than a few light machines for reconnaissance and gunnery observation duty, so that American reports to the contrary may be dismissed as unfounded.

A Colliery Management Experiment.

For some time past the Vauxhall Colliery in North Wales, between Wrexham and Ruabon, has been run at a loss, and recently the owners issued a notice expressing their intention to close the colliery on Tuesday, the 10th inst. The men, to the number of nearly 700, entered into conference with the owners, with the result that it was agreed to allow the men to run the pit for a period of three months, under the charge of the manager. A guarantee fund of £400 has been raised, wherewith the owners will be indemnified for any loss that may occur during the experimental period. If any profits result, they will be added to the guarantee fund and used to pay the subscribers interest at the rate of 5 per cent. The workmen are to receive the district rate of wages, and will work the usual hours without in any way contravening the Seven Hours Act. The negotiations leading up to the agreement were conducted independently and without the sanction of the Miners' Federation, and it is possible that as a result the Vauxhall men may be struck off their unions. The organisers of the Vauxhall scheme, however, contend that they have done nothing in contravention of the rules of their association. The sole object of the scheme, they say, is to keep the pit going, and so provide employment for the men, many of whom have been engaged at the pit all their lives. When the true facts of the case are understood, it is believed and hoped that the scheme will not be condemned by the unions untried.

The Shipbuilding Outlook.

In a leading article in last week's issue we outlined the serious position in which the British shipbuilding industry finds itself when opposed by present-day continental competition, and we expressed the hope that a joint inquiry into the whole position of the industry might be undertaken. Since that article was written, Sir Frederick Lewis, the chairman of Furness, Withy and Co., Ld., one of whose subsidiary companies recently placed an order for five 10,000-ton motor ships with the Deutsche-Werft, Hamburg, has informed both the Shipbuilding Employers' Federation and the Federation of Engineering and Shipbuilding Trades that he is ready to meet either party separately or both jointly to explain the facts connected with the placing of this order. Sir Frederick also proposes that as the determining difference in price between British and German built motor vessels only begins when speeds of over 10 to 11 knots are in question, the employers' and the men's representatives should endeavour by a joint inquiry to ascertain the reason of the difference in price. The Emergency Committee of the Federation of Engineering and Shipbuilding Trades has accepted Sir Frederick Lewis's offer, and negotiations between the employers and the unions regarding a joint meeting are in progress. It is quite possible that the inquiry proposed will lead to important developments. Meanwhile, several well-known shipbuilders have commented on the position. Sir George Hunter rightly denies that German shipyards are better equipped than are British yards, but inclines to the opinion that in the case of the Deutsche-Werft, careful organisation and specialisation in the construction of both hulls and machinery may have something to do with the lower price and quicker delivery. In a long communication to the Press, Mr. James Lithgow, of Lithgows, Ld., Port-Glasgow, reviews the various factors in the situation. In his opinion, the future cannot but hold a steady increase in the effectiveness of foreign competition unless the whole basis of British industrial costs is seriously modified, or, alternatively, unless there is a general uplifting of industrial wages and conditions in other countries.

The London, Midland and Scottish Railway's Electrical Department.

In order to deal more efficiently with electrical problems arising from the growing use of electricity on railways, the London, Midland and Scottish Railway has formed a special electrical department, which will be under the direction of Lieut.-Colonel F. A. Cortez Leigh. The department will deal with all classes of electrical work, including telegraphs telephones, lighting, wireless apparatus, track signalling and track electrification work. The Manchester–Oldham electrification scheme has already been handed over to the department. Colonel Leigh, who became chief electrical engineer to the old London and North-Western Railway in 1909, designed the electrification scheme for the present London, Midland and Scottish lines from Watford to Broad-street and Euston, and from Willesden to Richmond and Earl's Court, involving in all the electrification of 80 miles of track. The scheme included the erection of the power-house at Stonebridge Park, which is one of the most efficient traction stations in the country. Mr. J. Dalziel is assistant electrical engineer and Mr. J. Sayers, the telegraph superintendent.

A Coal Mining Inquiry.

On Wednesday a committee of sixteen members, representing the coalowners and the Miners' Federation of Great Britain, met for the first time in connection with a joint investigation which it is to make into the economic condition of the coal mining industry. The field to be covered will embrace an inquiry into the cost of coal production as affected by wages, transport rates and other factors, together with a comparison of the cost of production and output per man in countries competing with us. Of all the industries of the country coal mining is already the most fully analysed as regards cost distribution, and it is difficult to perceive in what direction the joint committee will be able to disclose fresh facts or figures. The operation of the wage boards results, month by month, in the compilation and publication of statistics which in volume and detail leave little wanting in the way of analysis. The cost per ton for wages, stores, royalties, insurance and compensation, power, rates and so on, are already very well known. That some good may come of the investigation is, however, greatly to be desired, for as the Minister of Transport remarked on Tuesday, we are threatened during the coming summer with a great industrial struggle which, headed by the miners, will embrace the workers in the railway, metal, engineering and shipbuilding industries. The miners would appear to think that their industry, so far as inland sales are concerned, is safe from foreign competition. From information revealed in Parliament on Tuesday, however, it would seem that their trust in this respect may shortly be shattered by a German syndicate, which, it is reported, is preparing to sell German coal in this country at rates lower than our own costs of production.

Marine Engineering Works Closing Down.

The severe depression in shipbuilding and the marine engineering industry is beginning to be manifested in a practical form which must appeal to all, workers and employers alike, connected with it. It is announced by Richardsons, Westgarth and Co., Ld., that the company's works at Middlesbrough will shortly be closed down and that such orders as are obtained will be executed at the firm's Hartlepool works. A notification has been issued that it may be impossible to retain the services of the majority of the staff at the Middlesbrough works longer than another month. Another North-East Coast firm of marine engineers, Blair and Co., Ld., of Stockton, have made a similarly significant statement. This company announces that unless extraordinary changes come over the local industrial situation it will be compelled to close down its works in six to eight weeks' time. The invitation of the Shipbuilding Employers' Federation to all the shipbuilding trades unions to meet in conference to discuss the position of British shipbuilding does not appear to have come a moment too soon.

The British Steam Railway Locomotive from 1825 to 1924.

By E. L. AHRONS, M.I. Mech. E.

No. XII.*

PERIOD 1849 TO 1855.

Intermediate Driving Shaft Locomotives.—Between 1848 and 1855 there was a revival of designs, in which the connecting-rods drove an intermediate or so-called "dummy" shaft. These included not only locomotives with inside cylinders and shafts of the crank axle type, but also outside cylinder engines with straight shaft and outside driving cranks. The original Wylam engines were of this general type, but the drive was conveyed from the shaft to the wheels through spur gearing. The drive through

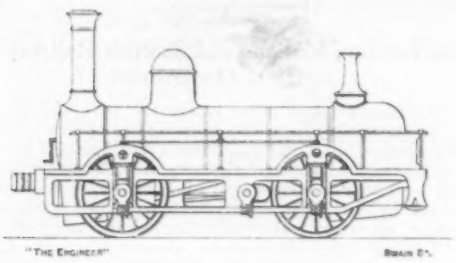


FIG. 73—VULCAN LOCOMOTIVE, 1848

coupling rods appeared in 1830 in Hackworth's mineral engines of the "Majestic" and "Wilberforce" classes, with six coupled wheels, and in others with the intermediate shaft placed midway between four wheels, such as Galloway's Caledonian of 1832 and Hawthorn's Swift of 1836. All these engines had outside vertical cylinders.

The engines of the 1849–1855 period had cylinders placed horizontally, or nearly so, and the chief consideration which prompted their design was the avoidance of the "nipping" of and the lateral blows on the flanges of driving wheels, which caused sudden bending stress on the axles. Moreover, the crank shaft, like that of a stationary engine, did not rise and fall with the springs, and it was contended that the steam distribution was consequently unaffected. On the other hand, the weight in the coupled engines of this type was carried on four wheels, and resulted in a greater load per axle. With the exception of Wilson's small engines, the others were used for mineral traffic, frequently on lines on which the track showed considerable inequalities. Under these conditions these coupled engines ran very steadily. They have frequently been referred to as Crampton's, but

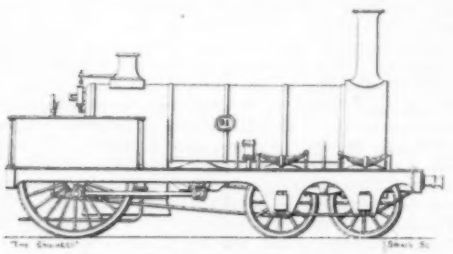


FIG. 74—INSIDE CYLINDER "CRAMPTON" ENGINE, 1849

his patents could hardly claim the design as new, since it had undoubtedly been anticipated in Galloway's engine of 1832.

The first of the new type were tender engines with inside cylinders and outside frames, and were simultaneously designed in 1848 by Messrs. Hawthorn for the Edinburgh Northern Railway and the Vulcan Foundry for the Shrewsbury and Chester Railway. The latter engine, which had 16in. by 24in. cylinders and 5ft. 3in. wheels, is shown in Fig. 73.

It was a large engine with boiler barrel 13ft. 4in. long, and of oval section, 4ft. 2¼in. vertically by 3ft. 6¼in. horizontally. The total heating surface was 1293 square feet. The wheel base was 11ft. 5in., and the crank shaft was placed 7ft. 4in. behind the leading axle. There were four elliptical springs enclosed within casings above each bearing. No record of the weight appears to have been kept.

A number of small tank engines with inside bearings were built in 1850–1, by E. B. Wilson and Co., Leeds. The cylinders were 11in. by 18in., and the wheels 5ft. diameter. Heating surface, 576 square feet; pressure, 100 lb. The tanks of some of the class had a capacity of 400 gallons. They were illustrated in THE ENGINEER, January 13th, 1880.

The last inside cylinder engines of this type in this country were built by R. Stephenson and Co. in 1851 for the Folkestone Harbour branch of the S.E.R. These were tank engines with 16in. by 24in. cylinders and 4ft. 6in. wheels, of which the axle bearings were inside. Between the frame and the outside driving cranks the excentrics for actuating the pump rods were placed. The cylinders were awkwardly arranged with an upward inclination towards the back and slide bars below the leading axle. Wheel base 12ft. 4in.; and total weight in working order 26 tons. The only brake power was provided by wooden blocks on the backs of the trailing wheels. Subsequently the engines were converted to 0–6–0 tank engines—see THE ENGINEER, July 1st, 1910.

In 1849 Crampton took out a patent for express locomotives with intermediate crank shaft and single driving wheels placed behind the fire-box. In 1851 a number of these were built by R. Stephenson and Co. for the S.E.R., and by R. B. Longridge and Co. for the G.N.R. Both series were of generally similar appearance—as shown in Fig. 74. The boilers were domeless, with the flush topped fire-box casing, long advocated by Crampton. The ten S.E.R. engines had a single inverted spring on each side for the two pairs of leading wheels, and differed from the G.N.R. engine, which had independent springs for each pair of wheels connected by compensating levers. The driving spring behind the fire-box was of the single transverse type placed in a box across the footplate, so that both classes had three-point suspension. The cylinders of the S.E.R. engines were 15in. by 22in.; driving wheels, 6ft. diameter; carrying wheels, 3ft. 6in. diameter; total wheel base, 16ft. The centre of the driving shaft was 7ft. in front of the driving axle, and 4ft. 6in. behind the second carrying axle. The driving shaft had bearings fitted with wedges both at the front and back, the axle-boxes being of brass. The tube heating surface was 1059 square feet, and the total 1153 square feet. Weight in working order 26¼ tons, of which only 10 tons were carried on the driving wheels.

The Great Northern engines had 6ft. 6in. driving wheels and 15in. by 21in. cylinders. It has hitherto been accepted that the G.N.R. had ten of these engines, Nos. 91 to 99 and 200, but the writer has recently found a letter from Mr. Sturrock, in which he stated definitely that there was only one "Crampton" on the line, and that the others were not of this type, but of his—Sturrock's—own design. This would refer to Nos. 91 to 99, which were of the 2–2–2 type, probably built originally as such, The form in which No. 200 was rebuilt seems to bear out the view that this was the only intermediate shaft engine.

In this design Crampton had to discard the low-pitched boiler, one of the principal considerations which decided his earlier outside cylinder design. To clear the inside crank shaft the boiler centre of the S.E.R. engines was placed 6ft. 5¼in. above rail level. There were also two rebuilt engines on the Brighton Railway of a similar type—see THE ENGINEER, July 1st, 1910.

The intermediate crank shaft reappeared in 1862 in five express engines—Fig. 75—built by Stephenson and Co. on Crampton's recommendation for the London, Chatham and Dover Railway, but in these a leading bogie was substituted for the two independent rigid leading axles. The hind driving wheels were placed further forward underneath instead of behind the fire-box, the long sloping grate of the latter permitting this modification. The driving wheels were 6ft. 6¼in. diameter, and the cylinders 16in. by 22in.; bogie wheels, 4ft. 0¼in. diameter; bogie wheel base, 4ft. 9in. The bogie pivot was 7ft. 10½in. in front of the crank shaft, and the centre of the latter 7ft. 3½in. from the centre of the driving axle. Total heating surface was 1198 square feet, of which the fire-box, of the Cudworth type, provided 129 square feet. The boiler centre was 6ft. 9in. above rail level.

None of the above intermediate shaft express engines were successful. Compared with the older outside cylinder Crampton engines, they suffered from the defect of having the smaller driving wheels too lightly loaded. In the earlier outside cylinder engines large driving wheels, 7ft. to 8ft. diameter, were usual, and the weight of these materially increased the adhesion, though with the accompanying disadvantage of a greater non-spring-borne weight. The G.N.R. engine, after a few years' service, was altered by Mr. Sturrock to the ordinary 2–4–0 type with middle driving wheels. The S.E.R. engines ran in their original condition until 1869, when Mr. Cudworth converted most of them to 2–4–0 engines. One only, No. 142, was provided in 1856 with a Cudworth patent fire-box for the purpose of experimental trials, but otherwise lasted in its original condition until 1874. The later L.C. and D.R. engines were also converted by Mr. Martley into 4–4–0 engines with double frames, the original bogies being retained.

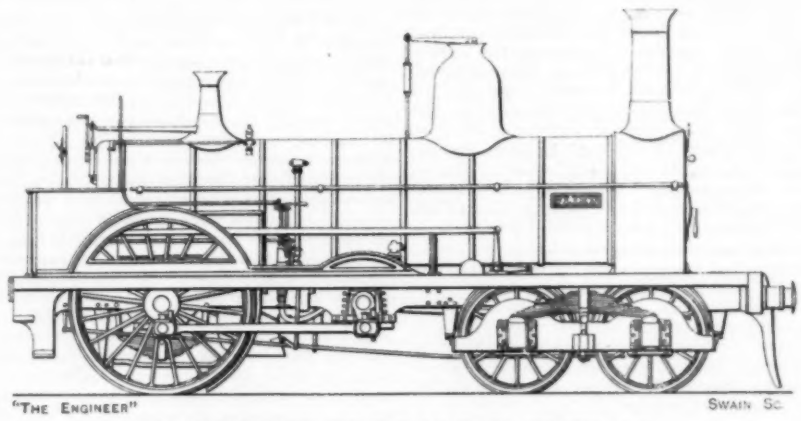


FIG. 75—LOCOMOTIVE FOR THE L.C. AND D. RAILWAY, 1862

The remaining type of intermediate crank shaft engines, which had *outside* horizontal cylinders, was introduced on the Caledonian Railway by Mr. Sinclair in 1853–4, and consisted of both tank and tender engines of moderate size for branch line mineral traffic. Mr. Patrick Stirling was the last engineer to design this type, and one of four engines for the Glasgow and South-Western Railway, for which he was responsible, is illustrated in Fig. 76. These were built early in 1855 by R. and W. Hawthorn, and had 5ft. wheels and 15in. by 20in. cylinders. They had a short life of about twelve years and then disappeared.

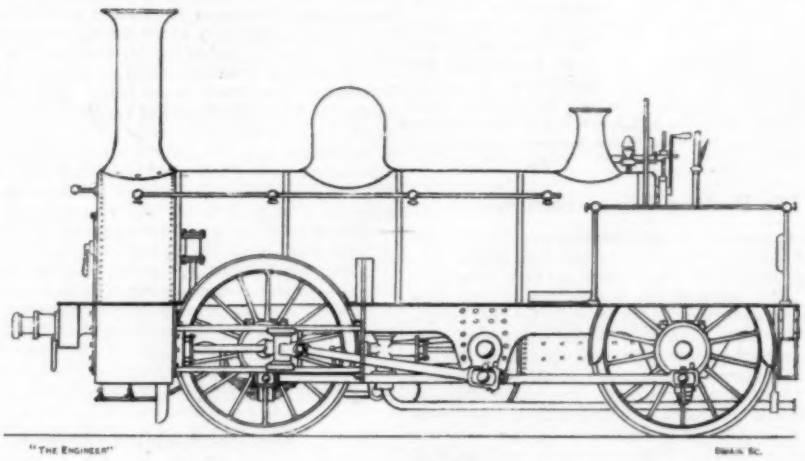


FIG. 76—P. STIRLING'S ENGINE FOR THE G. AND S.W. RAILWAY, 1855

Uniflow Locomotive, 1849.—Following the work of Bodmer, Crampton, Fernihough, and others in trying to improve the stability of locomotives, other engineers turned their attention to the work of the steam in the cylinders. Foremost amongst these were Daniel Gooch and D. K. Clark, whose labours have been so fully recorded in the standard book, "Railway Machinery," by the latter, that nothing need be added here.

* No. XI. appeared March 13th.

That a uniflow locomotive worked for about three years on the South-Eastern Railway is not so generally known. A short account of it was given in *The Railway Magazine* of June, 1907, before the Stumpff locomotive had appeared, and

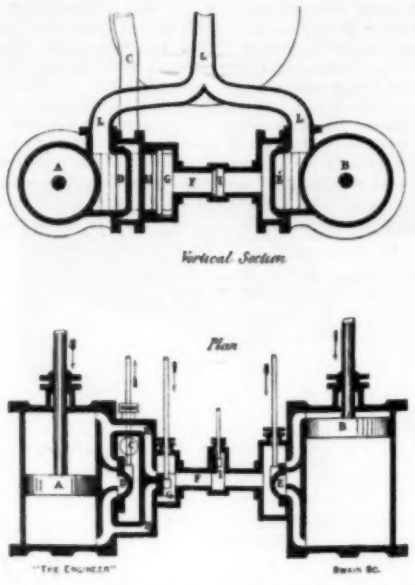


FIG. 77—CYLINDERS OF COMPOUND LOCOMOTIVE, 1852

it was also referred to in a letter in THE ENGINEER, April 25th, 1913, page 450. The uniflow stationary engine was proposed in this country in 1885 by T. J. Todd, who was preceded by Jacob Perkins. The S.E.R. locomotive of the 2-2-2 type was built in 1845 with ordinary 15in. by 18in. cylinders. The latter were replaced in 1849 by a new pair, the inside length of which was about twice the stroke, the latter remaining 18in. as before. The length of the piston was nearly one-half the length of the bore, and in the middle of the cylinder was an exhaust port which extended round half the circumference. When the piston had nearly completed its stroke, the steam was exhausted through the middle port into a pipe which passed round outside the cylinder barrel and entered the smoke-box from the outside on its way to the blast pipe.

Who was the originator of the idea is not known, but J. I. Cudworth was locomotive superintendent and would be responsible for its application, and also for its removal about three years afterwards. The reason for discarding it was not stated. But in the absence of balance weights for the reciprocating masses, it seems likely that the heavy pistons caused both fore and aft "surging" and excessive swaying.

Compound Locomotives.—The earliest compound locomotive was patented in 1850 by James Samuel, the engineer of the Eastern Counties Railway, though the credit of the invention was due to John Nicholson, an employee in the locomotive department. Two existing locomotives were converted in 1852 to the new principle, and were termed "continuous expansion" engines. They differed from a modern compound engine in that the steam was finally expanded in both high-pressure and low-pressure cylinders. The original arrangement provided for two cylinders, of which the low-pressure had a piston about 2.3 times the area of the high-pressure. The boiler steam admitted to the latter was cut off at about half stroke, at which point the low-pressure cylinder was just beginning its stroke, the cranks being at 90 deg. A communication was then opened with the low-pressure cylinder, and the steam expanded in both cylinders simultaneously, until the communication between them was closed by the valve. At this point the steam in the high-pressure cylinder was discharged into the blast pipe, whilst that in the low-pressure cylinder, the piston of which was at mid-stroke, was further expanded down to the lowest possible pressure consistent with efficiency. The underlying idea in this method of working, apart from considerations of fuel economy, was that there should be sufficient pressure of exhaust steam from both cylinders to maintain an effective blast. It was intended that the exhaust from the high-pressure cylinder, in quantity about 44 per cent. of the steam admitted, should escape at about 30 lb. per square inch, and that of the low-pressure cylinder at as low a pressure as possible, about 5 lb. per square inch.

The diagram—Fig. 77—taken from the Proc. Inst. Mech. E., 1852, shows the arrangement applied to an outside cylinder engine. Steam from the pipe C was admitted to the high-pressure cylinder A by the slide valve D. At half stroke the supplementary slide valve G, controlled by a fifth excentric, was opened and allowed the steam to exhaust through passages H and F into the low-pressure steam chest containing the slide valve E. A starting valve I was provided by which the driver could close the passage F. This was non-automatic, and at the same time an additional cock had also to be opened to admit boiler steam into the low-pressure cylinder. By this arrangement the engine could be worked non-compound whenever extra power was required.

It was intended to use steam of 160 lb. pressure, but as the two engines which were fitted with the arrangement had old boilers, there is no doubt that the boiler pressure did not exceed 100 lb. to 110 lb. Moreover, in one of them—a 2-4-0 for goods traffic—the high-pressure and low-pressure cylinders were of the same size, 15in. by 24in., and consequently the "compound" system was applied at a great disadvantage. The reason for this appears to have been that it was feared that the blast might prove insufficient, and it was decided to test this experimentally before going to the expense of a large low-pressure cylinder. It is very doubtful whether the other—a passenger—engine was not similarly handicapped, since both were fitted up at the same time. It was stated that 12 lb. of coke per mile were saved, probably largely on account of the inefficiency of the original simple engines. As a "compound" the system had the defect that the difference between the initial and final temperatures of the steam in the high-pressure cylinder was as great as in the simple engine, since the final exhaust from this cylinder communicated directly with the atmosphere. Other causes appear to have precluded a fair locomotive trial, and Nicholson took the idea to a Mr. Stewart, who had works in London,

FIG. 78—TANK ENGINE, EDINBURGH AND GLASGOW RAILWAY, 1850

where several stationary engines working on this continuous expansion system were subsequently built.

Passenger Tank Engines with Single Driving Wheels.—Following the combined engines and coaches of W. B. Adams, a considerable number of passenger tank locomotives were built during 1850–1855 for branch line traffic, though in many cases they were used for light main-line trains. The majority had single driving wheels; one or two four-coupled types will be noticed subsequently.

The outside cylinder well tank engine by Sharp, Roberts has already been mentioned. A smaller well tank engine by Neilson, 1850, for the Edinburgh and Glasgow Railway, is shown in Fig. 78. The cylinders, 10in. by 15in., were placed behind the leading wheels, and the driving wheels, 5ft. diameter, were under the footplate. The saloon at the back did not form part of the original engine, but was added with the new boiler about twenty years later.

Sinclair on the Caledonian Railway adopted a modification of the "Crewe" type of engine which had 9in. by 15in. cylinders and 5ft. 1in. driving wheels. It had straight separated plate springs for the leading and trailing wheels, and a single transverse driving spring—see Clark's "Railway Machinery," Plate 24. Brake blocks were applied to the trailing wheels only, as was the case in almost all tank engines of that day. Gooch's

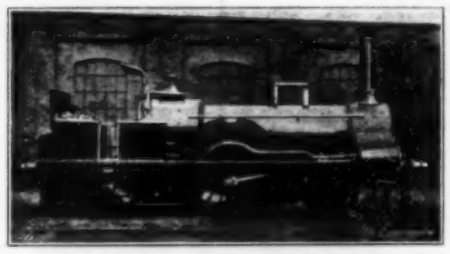


FIG. 79—TANK ENGINE, EASTERN COUNTIES RAILWAY, 1851

stationary link motion was used, with built-up expansion links. The cylinders were horizontal, but in the "Crewe" type tank engines by Jones and Potts, Kitson, and J. V. Gooch, they were inclined to clear the leading wheels.

J. V. Gooch's celebrated express tank engines of 1851–1854—Fig. 79—were used on the Eastern Counties Railway for light main-line trains. The driving wheels were 6ft. 6in. diameter, and in the earlier engines the cylinders were 12in. by 22in., increased in the later ones to 14in. by 22in. Heating surface of the latter, 707¼ square feet; boiler pressure, 110 lb. As in J. Gooch's previous L. and S.W.R. engines, the gridiron regulators were placed close to the inlet of the steam pipe into the steam chest. Incidentally, it may be mentioned that these were the first engines built at Stratford Works.

W. Fairbairn and Sons in 1850, followed by the Vulcan Foundry in 1853 and Neilson in later engines, adopted inside cylinders combined with inside framing throughout. Fairbairn's tank engine—Fig. 80—is interesting in that solid welded plate frames were used. These engines, although of extremely small size, worked the lighter passenger trains on the "Little" North-Western Railway—*i.e.*, the line from Skipton to Morecambe, which afterwards was merged into the Midland system. The cylinders were 9½in. by 15in., and the driving wheels 5ft. diameter. D. K. Clark, who mentioned them, gave the weight as 14 tons only, of which 7½ tons were carried on the driving wheels, but though no definite statement is made, it seems likely that this was the weight empty. The majority of the engines of this type were built for various railways in Ireland.

The Vulcan Foundry engines[1] for the Dublin and Wicklow Railway had saddle tanks and Dodds's wedge motion. The driving wheels were 5ft. 3½in. diameter and the cylinders 13in. by 20in. Total heating surface, 776¼ square feet.

Neilson's engine of this type—Fig. 81—though built in 1862 for the Dublin and Drogheda Railway, may be mentioned here. It was unique in having both side and saddle tanks, and was one of the earliest to have the footplate completely roofed in. The cylinders were 12in. by 18in., and the driving wheels 5ft. 6in. diameter.

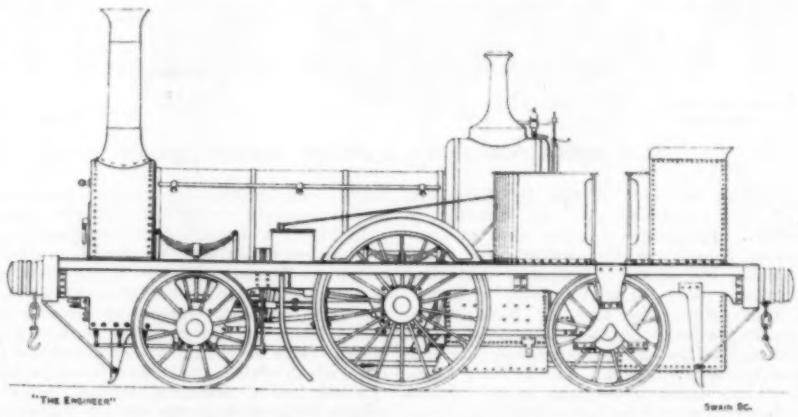


FIG. 80—TANK ENGINE BY W. FAIRBAIRN AND SONS, 1850

[1] Illustrated in D. K. Clark and Colburn's "Recent Practice n the Locomotive Engine," 1860, Plate 39.

E. B. Wilson's 2–2–2 tank engines were somewhat similar to those of Fairbairn, but the bearings of the carrying wheels were outside, as in the "Jenny Linds." The cylinders were 10in. by 17in., and the driving wheels 5ft. 6in. The weight in working order was 19½ tons. A characteristic of both Wilson's and Fairbairn's early tank engines was the domeless boiler. In place of the dome, the fire-box casing—as in Fig. 80—was raised 1ft. above the barrel to provide a steam space, though the steam was taken from a perforated pipe at the top of the barrel. The raised flat ends of the casing were stayed by means of short longitudinal stays secured to angle irons. This form of raised fire-box casing was used for many years by Manning, Wardle and Co. in tank engines built by them.

George England and Co., of Hatcham Ironworks, London, built a number of extremely neat well tank engines—see Clark and Colburn, Plate 42—between 1850 and 1856. The inside cylinders, 9in. by 12in. were placed behind the leading

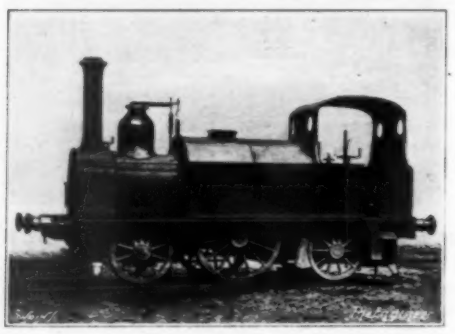


FIG. 81—NEILSON AND CO.'S TANK ENGINE, 1862

axle, and the connecting-rod was 3ft. 5in. long. The framing was of the outside sandwich type, with outside bearings only. The driving wheels were only 4ft. 6in. diameter; nevertheless, the engines were reputed to be excellent runners. The total wheel base was 12ft. 8in. D. K. Clark records that their duty was to take seven carriages on a run of 47½ miles with six stoppages, at a speed of 36 miles per hour on a consumption of 9.7 lb. coke per mile.

Sharp, Stewart and Co. discarded the outside cylinder inside-framed type for one with inside cylinders and double sandwich frames. Those built by the firm had the usual well and back banks, but a large number for the London and North-Western Railway—Fig. 82—of which the boilers, frames and cylinders were made by Messrs. Sharp and the remainder of the work, including erection, was done in 1854–1858 at Longsight, Manchester, under Mr. John Ramsbottom's supervision, had saddle tanks. Mr. Ramsbottom was originally chief locomotive superintendent of the Manchester and Birmingham Railway, with headquarters at Longsight; he remained there as chief of the North-Eastern Division of the L.N.W.R. until his removal to Crewe in 1857. The above engines were in most other respects similar to the well-known 2–2–2 tender engines by Sharp Brothers, and had 5ft. 6in. wheels and 15in. by 20in. cylinders. Some of them were the first to have Ramsbottom's safety valves. For a considerable period they worked the local traffic from Manchester (London-road) to Stockport, Macclesfield, and Alderley Edge.

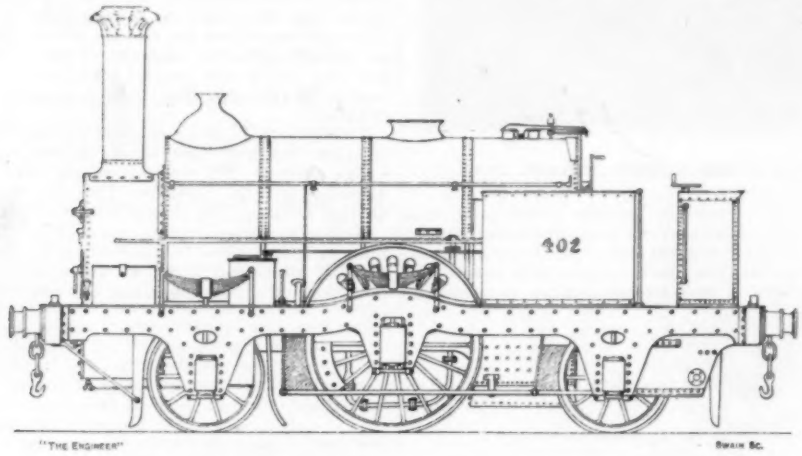


FIG. 82—SADDLE TANK ENGINE, L. AND N.W. RAILWAY, 1854—1857

After 1858 the single driver tank engine almost died out. A few were built as late as 1866 by Sharp, Stewart and Co. for the Furness Railway, and a number of Sharp's old tender engines were converted to tank engines on the G.N.R. and L. and N.W.R. for light branch line service. In Ireland the type held its own for several years longer, notably on the Dublin, Wicklow and Wexford Railway, for which a considerable number of the inside-framed type were built between 1865 and 1873.

Institution of Mechanical Engineers.

On Friday of last week two further reports to the Cutting Tools Research Committee were submitted for discussion before the Institution of Mechanical Engineers. The first, entitled "The Action of Cutting Tools," was contributed by Professor E. G. Coker, and the second, "Experiments with Lathe Tools on Fine Cuts and Some Physical Properties of the Tool Steels and Metal Operated Upon," by Mr. Dempster Smith and Mr. Arthur Leigh. We append summaries of these two reports.

The Action of Cutting Tools.

In 1922 Professor Coker presented before the Institution a paper on the action of lathe tools, as determined by optical examination. In the paper presented last Friday he dealt primarily with the cutting action taking place in milling and milling machines, as revealed by his well-known photo-elastic method. A machine was devised whereby the cutting action of a milling cutter on the edge of a transparent plate of nitro-cellulose or other material could be examined and the stresses generated could be inspected by means of the colour bands revealed when a polarised beam of light was passed transversely through the "work." The machine was so designed as to be readily convertible to a planing machine, the tool acting similarly on the edge of a nitro-cellulose plate.

FIG. 1.—*Planing Tool Operating on a Strip of Nitro-Cellulose in Polarised Light.*

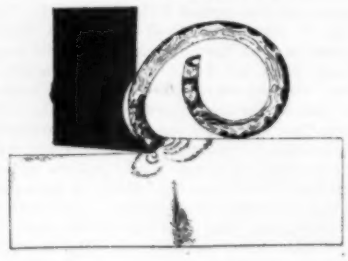
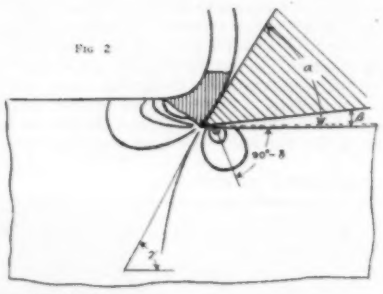


FIG. 2



In Fig. 1 a sketch reproduced from a photograph is given showing the action of a planing tool on nitro-cellulose. The colour bands in the shaving and work and the stress distribution deduced from them present the same essential features as those found in the earlier lathe experiments. The angle γ, Fig. 2, of the opaque black brush, stationary in front of the cutting edge, which divides the area under radial tension from the area under radial compression, was found to be greatly different from the cutting angle α of the tool when α was small, but to tend towards equality with α when the cutting angle approached 90 deg. Similarly the inclination δ of the line perpendicular to the axis of the tension lobe tended towards equality with α, when α was large, but was widely different from it when α was small. The data derived from these measurements afforded a clue to the general direction of the force exerted by the point of the tool on the work, but it was discovered that the subject was complicated by an "uplift effect" mentioned hereafter.

It was observed that after a cut had been taken and the tool run back, the point of the tool sometimes failed to make contact with the work, particularly if the tool angles were such as to leave the surface of the work somewhat rough. The same effect was observed in some cases with metal instead of nitro-cellulose work pieces. On a small, new shaping machine it was found that over a wide range of depth of cut the metal shaving removed was thicker than the depth of cut indicated by the micrometer on the machine. The difference was too great to be accounted for wholly by the plastic stress and strain to which the shaving was subjected. The gap was small when the tool angles used were such as to give clean-cut surfaces, and it was deduced that the gap was primarily a function of the cutting angles. In a new 8in. centres Lang lathe, with the tool supported in a most rigid manner, it was found that a tool with a cutting angle of 45 deg. and a clearance angle of 3 deg., when set to a feed of 0.015in. produced a gap of 0.003in., with steel, and a still greater gap with nitro-cellulose. The action of the tool was observed under a microscope, giving a magnification of 40 diameters, and it was discovered that in circumstances producing a gap the tool pulled up the material locally in such a way that—as indicated in Fig. 3—straight parallel lines ruled on the front of the work developed bulges under the tool point. This distortion diminished regularly in the vertical direction, and tended to vanish at some depth below the cut surface. When this uplift occurs, it is suggested, the consequent tearing action may produce the roughness of the surface of the work noted in such cases. With tools of large cutting angles, the peak under the cutting edge may be directed downwardly, while if the tool does not tend either to tear the shaving away from the work or force it into the work there is an absence of permanent distortion of the parallel lines ruled on the material. The addition of a trace of lubricant was found greatly to modify the extent of the distortion. It is noted that mechanical operations were often insufficient to ensure the absence of all trace of lubricant, and that they had to give way to chemical means.

FIG. 3.—*Diagram showing the Distortion and Uplift of lines ruled on the Work parallel to the line of Motion of the Tool.*

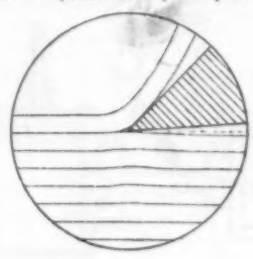
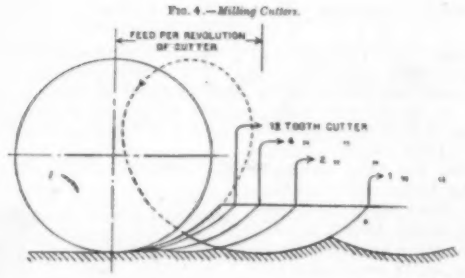


FIG. 4.—*Milling Cutter.*



Passing to the action of milling cutters, the author remarks that the combined rotation and feed cause each tooth to describe an oblate trochoidal curve—see Fig. 4—with the result that the shaving removed is not uniform, but increases in thickness as the cut proceeds. This fact results in features that are not present in cuts of the lathe or planing machine type. With a single cutting edge, the area in front of the "black brush" springing from the point of the tool is in compression and the part behind it in tension. With a milling cutter, two or more cutting edges are in action simultaneously, and as a consequence at some point in the work between a pair of consecutive cutting edges the pull on the work caused by one edge is neutralised by the push of the other behind it. This fact is revealed under polarised light by a black patch between each pair of teeth—see Fig. 5. The changes occurring at the two cutting edges do not, however, vary in the same manner at the same time, and as a result, it is found that the black patch in the work between the teeth does not remain stationary. In addition, it has been observed that the black brush associated with each cutting edge alters its inclination relatively to the contour of the cut surface as the tooth advances. At first it may be nearly radial to the contour, but towards the end of the engagement it may be 20 deg. in advance of its first position. The point of zero stress indicated by the black patch between the teeth advances towards the cutting edge in front of it, as the cut proceeds. The change from

compression to tension which occurs at this point, is, it is noted, very rapid. Some indication of the actual stresses produced in the work as deduced from an analysis of the colour band formations is given in Fig. 6.

Concluding his paper, Professor Coker remarks that the photo-elastic investigation of the action of cutting tools has now reached a stage at which there is a reasonable prospect of further development if certain fundamental investigations are carried out. In this connection, he briefly describes some initial attempts to measure the stress in both the work and

FIG. 5.—*Milling Cutter Operating on a Strip of Nitro-Cellulose in Polarised Light.*

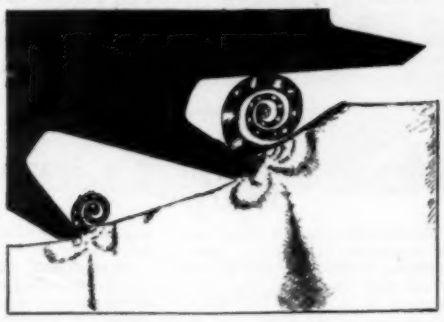
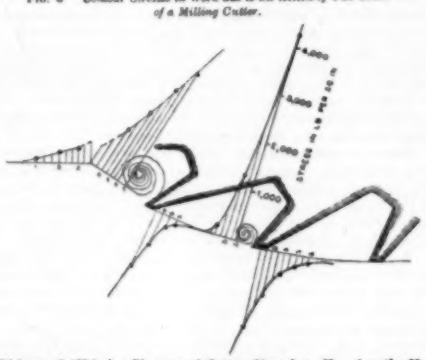


FIG. 6 *Contour Stresses in Work due to the Action of Two Teeth of a Milling Cutter.*



Thickness—0·177-inch. Diameter of Cutter—3¼ inches. No of teeth—22 Feed—0·008-inch per $\frac{1}{10}$ of rev. Cutting angle—60° Rake—30° Clearance 5° Material removed to a depth of ⅛-inch.

"THE ENGINEER" Swain &c.

the tool by the employment of a steel tool and one of an exactly similar form, of nitro-cellulose or bakelite, which is run into the cut after the cut has been made by the steel tool.

LATHE TOOLS AND FINE CUTS.

Previous investigations by a large number of workers have shown that the durability of cutting tools when taking heavy cuts decreases continuously as the cutting speed is increased. On light cuts, however, Mr. E. G. Herbert, in 1908, showed that the durability as the speed is increased rises to a maximum, falls, increases to a second maximum, and finally decreases without further interruption. Mr. Herbert's results have been disputed, largely on the ground that they were obtained on a special machine. Messrs. Smith and Leigh therefore determined to carry out a series of tests in an ordinary lathe, using a depth and traverse of cut closely corresponding to those employed in Mr. Herbert's experiments.

The lathe was equipped with a dynamometer designed to measure the vertical force on the tool when in action. The durability of the tool was taken to be the length of time elapsing from the start of the cut until the vertical force recorded on the dynamometer was 10 per cent. greater than its original value.

The tools used were of two kinds, namely, of carbon steel (Hadfield), with the following composition, C 1.28, Mn 0.28, Si 0.10, Ni 0.065, P 0.018, and S 0.005; and high-speed steel (Armstrong-Whitworth), containing C 0.65, W 13.08, Cr 2.97, and Va 0.52. The metal operated upon was a medium steel of 41.6 tons tensile strength, having the composition, C 0.35, Si 0.15, Mn 0.14, S 0.06, and P 0.04.

The hardness of the tool and work steels was measured over a range of temperatures by means of a Herbert "pendulum" hardness tester—time test—fitted with a 1 mm. hemispherical diamond. From Figs. 7 and 8 it will be seen that the carbon and high-speed tool steels showed definite maxima and minima in their hardness curves, as the temperature of the test increased, all ending, however, in a fairly sharp and permanent fall. It is particularly to be noted that the high-speed steel, when hardened only, was less hard than the same material when hardened and subsequently heat treated. The hardness of the medium steel used for the work—as shown at the foot of Fig. 8—descreases slightly from the cold up to about 100 deg. Cent., but then increases until at 300 deg. it is greater than the hardness when the metal is cold.' From 300 deg. to 430 deg. Cent. the hardness is practically constant, after which it falls rapidly.

The first series of experiments was directed towards determining the durability of the carbon steels, as affected by the cutting speed when a very fine cut, 0.0625in. deep, and with a traverse of 0.0013in., was being taken. The results are plotted in Fig. 9. Both the hardened and the hardened and tempered tools gave curves exhibiting two maxima. On the assumption that the principal factors affecting the durability of the tool are the resistance to cutting of the work steel and the resistance to abrasion of the tool steel, and on the further assumption that these resistances are measured by the hardnesses of the steels, then, according to the authors, the ratios of the two hardnesses ought to give a curve corresponding to the durability curve when the temperatures appropriate to the cutting speeds are determined. It was found, however, that a curve so constructed only showed approximate agreement, and it was concluded that some other factor, possibly vibration or the work hardness of the tool steel, was affecting the durability.

In the second series of experiments the durability of the high-speed tools was studied as the cutting speed increased and as the cut was altered from extremely light to something approaching a roughing cut. The results obtained are plotted in Fig. 10. It will be noticed that the cut was increased by keeping the depth constant and augmenting the traverse. On the lightest cut, the curve shows two maxima for the durability, namely, at 40ft. and 155ft. per minute. On the second lightest cut, the second maximum is shown at 80ft. per minute, the first being indicated apparently in the neighbourhood of zero speed. On the second highest and highest cuts, the maxima occur at 55ft. and 20ft. per minute respectively. The first maxima have become eliminated.

The durability curves thus move towards the left as the cut is increased. The explanation of this phenomenon is stated to be the increase in the temperature of the shaving and work resulting from the increased heat generated by the heavier cuts. It would appear

FIG. 7.

Variation of Pendulum Time Hardness with Temperature for Carbon Steel.

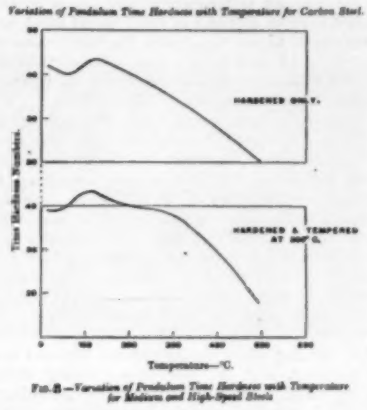
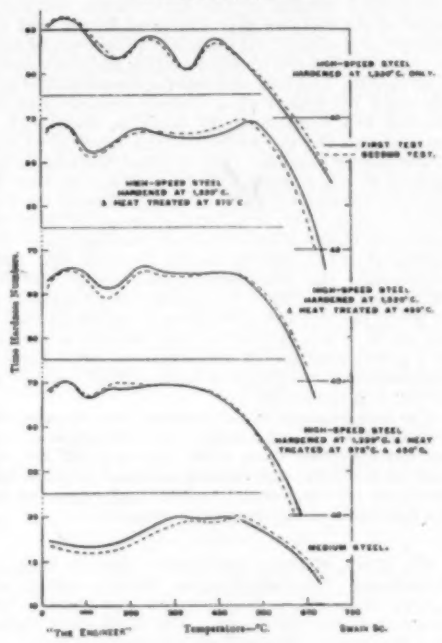


FIG. 8.—*Variation of Pendulum Time Hardness with Temperature for Medium and High-Speed Steels*


HIGH-SPEED STEEL HARDENED AT 1,300° C. ONLY.
FIRST TEST.
SECOND TEST.
HIGH-SPEED STEEL HARDENED AT 1,300° C. & HEAT TREATED AT 575° C
HIGH-SPEED STEEL HARDENED AT 1,300° C. & HEAT TREATED AT 430° C.
HIGH-SPEED STEEL HARDENED AT 1,300° C. & HEAT TREATED AT 575° C. & 430° C.
MEDIUM STEEL.
Time Hardness Numbers.
"THE ENGINEER" Temperature—°C. SWAIN &C.

that as the cut is increased the peaks tend to disappear, until when roughing cut conditions are approached the curve takes the progressively falling form associated with such roughing cuts.

In the next series of experiments the durability of high-speed tools as affected by secondary heat treatment and the use of a cooling medium was studied. The results obtained by the authors are indicated in Fig. 11. It is noted that the tool hardened only at speeds up to about 120ft. per

FIG. 9.—*Variation in Durability with Cutting Speed for Carbon-Steel Tools*

Depth of Cut—0·0625-inch Traverse—0·0013-inch

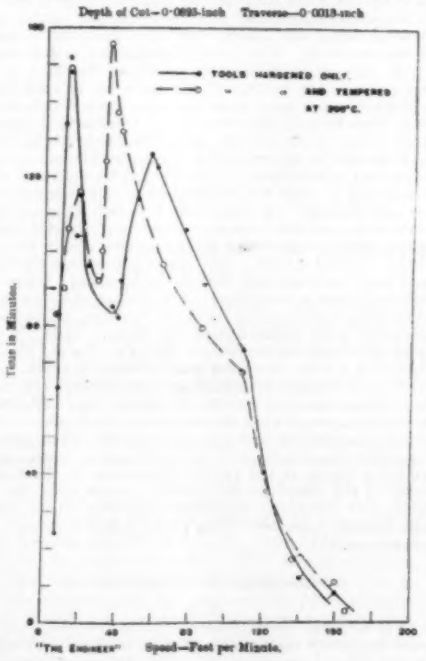


FIG. 10.—*Variation in Durability with Cutting Speed when Operating with Varying Traverse.*

High-Speed Steel Tools—Hardened at 1,260° C., and Heat Treated at 575° C. Constant Depth of Cut 0·0625-inch.

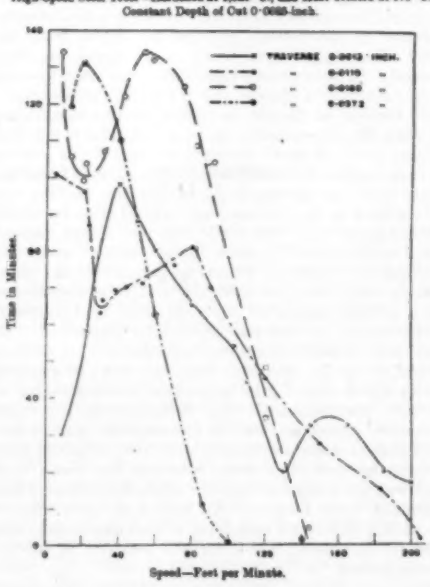
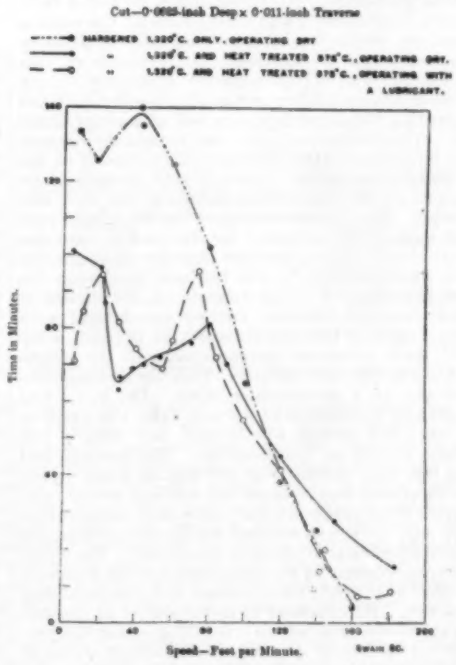


FIG. 11.—*Variation in Durability with Cutting Speed for High-Speed Steel Tools.*

Cut—0·0625-inch Deep x 0·011-inch Traverse


HARDENED 1,320° C. ONLY, OPERATING DRY
" 1,320° C. AND HEAT TREATED 575° C., OPERATING DRY.
" 1,320° C. AND HEAT TREATED 575° C., OPERATING WITH A LUBRICANT.
Time in Minutes.
Speed—Feet per Minute.
SWAIN &C.

minute has a much greater durability than those hardened and heat treated, in spite of the fact that—as shown in Fig. 8—the latter tools possessed the greater hardness. It is also noted that comparing Fig. 10 and Fig. 11, the carbon steel at low speeds has, on the average, a durability as good as the high-speed steel, from which fact it is suggested that it would be just as satisfactory and more economical to employ carbon instead of high-speed steel for files, hand reamers, taps, &c., used for light cuts at low speeds. Fig. 11 also brings out the fact that at high speeds the durability is not increased by the use of a lubricant. Contrary to the common belief, the durability with a cutting compound did not reach the value of the durability when the tool was run dry. When water alone was used, the durability was even less, as indicated by the dotted circles. Photomicrographic examination of the material suggested that this peculiar result was due to the high temperature generated by the cut and the immediate quenching and hardening of the eutectic pearlite patches. The depth of hardening by this quenching action is, however, only small, and it is only on very light cuts, such as that used in the experiments, that the hardening effect would be noticeable. Thus on heavier cuts the cutting edge would extend beyond the hardened patches, and the use of a cutting compound or cooling medium would increase the durability.

The final section of the experiments covered a study of the temperatures generated in the tool and shaving, and also of the changes in the vertical force on the tool when the speed of cutting and the traverse were varied. The tool and shaving temperatures were measured by means of a thermo-couple. For the shaving the thermo-couple junction was held in contact with the top surface of the shaving, as near to the bar as possible. For the tool the couple was applied within a small hole in such a way that the junction was within $^1/_{100}$in. of the top face of the tool. It was found that at a cutting speed of 10ft. per minute, a temperature of about 150 deg. Cent. was registered in the shaving for all the cuts. At 100ft. per minute the temperature was about 250 deg. Thereafter, it increased less rapidly, reaching 300 deg. at 200ft. per minute. The view is advanced that at the plane of separation the temperature is constant at a given speed for all dimensions of cut. The tool temperatures were found to be unreliable, and are not recorded in the paper.

The investigation of the vertical force showed that with the depth of cut constant at 0.0625in. and varying the traverses from 0.0013in. to 0.0372in., the vertical force did not remain constant at all cutting speeds as previous experimenters had suggested was the case for ordinary roughing cuts.

Mr. E. G. Herbert was called upon to open the discussion. He characterised Messrs. Smith and Leigh's report as a link between experiments with heavy and with light cuts. The work done showed that the results obtained with heavy and light cuts, in spite of their seeming fundamental difference, were not inconsistent with each other, and were not discontinuous. In terms of temperature, roughing cut experiments revealed the durability of the tools over a somewhat restricted range of high temperatures. Light cut experiments showed the durability over a wide range of temperature extending from atmospheric to some high value. It was evident, he continued, that the heat treatment of a tool might spoil its durability. By tempering it to suit a temperature that would not be reached during the cutting action, its durability at the temperature actually generated might be lowered. An example of this fact was shown by the superior durability of the hardened only tool shown in Fig. 11. We were justified in regarding the durability of a tool as a temperature effect. Temperature affected the durability because of its influence on the hardness of the metal of the tool and the metal of the work, and because of its influence on the interaction between the tool and the work. The peaked durability curves at light cuts would seem to be explained by the peaked hardness curves, were it not for the fact that the most durable of the high-speed tools was the one possessing the lowest hardness. The experiments on the change of vertical force at different cutting speeds and with different rates of traverse revealed, he noticed, a dip in the force curve at cutting speeds in the neighbourhood of 20ft. per minute. This dip he suggested might also be a temperature effect. Dr. F. C. Lea had recently shown that at 300 deg. Cent. the ductility of a steel was almost wholly lost, and that it was regained at higher temperatures. He himself had found the same shortness at 300 deg. in many steels. Such shortness would assist the cutting action, and therefore if we supposed that some such temperature as 300 deg. Cent. was reached during the cutting, the dip in the force curve would be explained. The work-hardening property of the metal was another temperature effect that might be correlated with the durability of the tool. He appealed to metallurgists to descend from the clouds and tell us something about the properties of the steels we used at the temperatures at which we used them, instead of confining attention to the temperatures at which we hardened and heat-treated them. The metallurgists might reply by asking what the temperatures were at which we used our steels, and it had to be admitted that there was much uncertainty in this connection. The thermo-couple applied in the usual way was an unreliable method of measuring the temperature generated between the tool and the work. He himself had recently used an improved thermo-couple method, in which one of the elements was the steel being cut and the other was the tool itself. For that purpose he used a "Stellite" tool and insulated it from the slide rest. Taking a cut $^1/_{1000}$in. deep by $^1/_{16}$in. wide at 200ft. per minute, he found a temperature of 700 deg. Cent., when the cutting was being done dry. The tool and chip became red hot, and the tool speedily failed. With the same cut and at the same speed a temperature of 500 deg. Cent. was recorded when the tool and work were flooded with cold water. In spite of the fact that the tool and work were apparently cold, the tool soon failed from local overheating. The tool became soft by local heating, a small portion was rubbed off, and a fresh portion was exposed to the local attack.

Dr. T. E. Stanton emphasised the importance of Mr. Dempster Smith's discovery that as the cut became heavier the durability curve moved farther and farther back towards the zero ordinate. It had, he continued, been shown by Dennis, a French authority on the action of cutting tools, that if the highest performance of a tool was registered at a cutting speed V, the most economical speed to employ was one equal to $^4/_3$ V.

Mr. R. Macdonald, referring to the gap found by Professor Coker under certain conditions between the work and the tool after the cut had been taken, suggested that this effect might be traced in a planing machine to the hinging of the tool about the lowest edge of the face against which it was supported. The two reports, he proceeded, represented a case of doctors differing, for while one suggested that lubricants were not of much value, the other attributed considerable benefit to their employment. General experience was to the effect that on roughing cuts a lubricant was not of great use. Mr. Smith's medium steel showed, he noticed, a fairly high carbon content. He thought it would be useful to know whether the results would have been modified had a steel with lower carbon content been used. Recalling a railway axle lathe exhibited at Wembley, in which the tool took the form of a saucer-shaped disc, he remarked that in view of the important effect on the properties of the work which the temperature generated during the cutting action apparently exercised, it might be held that railway travelling was a more sporting affair than we believed.

Mr. R. W. Bailey asked Professor Coker whether he could state to what depth material was damaged by the punishing effect of a heavy cut. Turning to Mr. Smith's paper, he called attention to the fact that the maximum hardness recorded for the carbon steel tools—something over 40 on Mr. Herbert's time test scale—corresponded with a Brinell hardness number of about 400. Such a figure, he urged, was very low. A Brinell hardness of about 600 would be more in accordance with ordinary experience. Fine cuts, he continued, were usually employed on hard material. In spite of the fact, however, that Mr. Smith's work steel was of mild quality, having a Brinell hardness of perhaps 20, the results might be applied to much harder material, such as die tool steel having a hardness number of 500. He had had experience with such a material. With a fine cut, it was found possible to machine it with a carbon steel tool hardened right out, and not given any secondary heat treatment. This experience confirmed Mr. Smith's result.

Mr. F. N. Robinson asked Professor Coker whether the teeth of his milling cutter were parallel with the axis or were given a slight spiral, and, if so, whether the spiral formation had any effect on the stresses produced in the work. He did not agree with Mr. Bailey that light cuts were only useful on hard material. In many cases light cuts were used because heavy cuts would distort the material excessively.

Mr. Dempster Smith, replying to the discussion, said that his experiments had been conducted with a medium steel of shell quality, in which the carbon was not uniformly distributed. He agreed with Mr. Bailey that the hardness figure for the carbon tool steel seemed to be too low, and stated that he would re-investigate it. The force on the round saucer-shaped tool on the Wembley lathe, referred to by Mr. Macdonald, would no doubt be greater than on an ordinary tool, but the shaving would be distributed over a greater length of the tool edge, and therefore the durability of the tool would be improved. He could not accept Commandant Dennis' deduction referred to by Dr. Stanton, that the most economical cutting speed was $^4/_3$rds the speed corresponding to the best performance. In determining the most economical speed, one had to compare the gain due to the increased speed of cutting with the complete costs involved in removing and replacing the spent tool. There was no evidence that the French authority had considered these factors. He was very interested to hear of Mr. Herbert's new form of thermo-couple, and hoped to be able to use it for the purpose of further investigations.

Professor Coker also welcomed Mr. Herbert's thermo-couple system, and said that it looked as if it would provide a fruitful means for investigating temperature effects of all kinds. Mr. Macdonald's explanation of the gap between the point of the tool and the cut surface could not be applied to his—Professor Coker's—experiments. The tool was supported right to the very end, and the tool rest, in addition, was strutted up. Moreover, a mirror was applied to the point of the tool in order to measure any bending or deflection that, even with these precautions, might occur. It was found that when a gap was noticed between the tool and the work surface, the measured deflection of the tool nose was much too small to account for the whole of the gap. He disclaimed the existence of any real difference between himself and Mr. Smith in the matter of the value or otherwise of a cutting lubricant. Replying to Mr. Bailley, he stated that no systematic investigation had yet been made of the depth to which the punishment of the material penetrated under a heavy cut. The milling cutters used were provided with straight teeth. Spiral teeth would have twisted the shavings sideways and interfered with the taking of the photographs.

Effective Sluicing from a Spanish Reservoir.

Remarkable results of the use of large-capacity sluices are described, in a recent issue of the *Revista de Obras Publicas*, by D. Jorge Jordano, an engineer closely associated with the design and use of a reservoir called the Pantano de la Peña. It is situated on the river Gállego, a tributary of the Ebro, and stores water for irrigation. The associations responsible for the construction of the works own about 10,000 hectares of irrigable lands to which water is supplied partly from the regulated flow of the river and partly by canals fed by the reservoir. These lands are, however, situated downstream of some 7000 hectares of irrigable lands belonging to other persons, and the river in this tract is provided with weirs which supply irrigation canals from which these cultivators benefit, having contributed nothing to the cost of building the dam, and paying nothing for the water.

The size and character of the works may be judged from the following normal balance sheet:—Available water, 24 million cubic metres; used in legitimate irrigation, 5 (? 15) million cubic metres; losses by evaporation and absorption in the reservoir and in 120 kiloms. of canal, 5 millions; losses by other irrigation, 4 millions.

Sr. Jordano states very emphatically that the capacity of the reservoir increases every year. The river is subject to big floods which carry much silt. To combat the expected deposition of silt in the reservoir two sluicing tunnels were provided in the design, each with three sluices, and together capable of discharging the whole of an ordinary flood. Their effect is such that, in spite of the constant re-filling of the reservoir and the normally high level of the calm water, the flow of the river in its old bed is re-established when the sluices are opened. The receding waters of the reservoir, uncovering the beds of the tributary streams, disclose their gravels, not covered by silt, and their banks washed clean. These tributaries, or most of them, are "ramblas," or seasonal torrents, which are dry for the greater part of the year. Since the accumulation of silt usually takes place in the upstream shallows of a reservoir, this effect is notable enough in itself; but Sr. Jordano affirms that the effect of the sluices is greater than that necessary to carry away the silt brought down to the top-water level, and actually results in enlarging the bed of the reservoir. It does not follow that erosion must occur when the sluices are open in a flood, though possibly it actually does so. In that case the under-tow established by the sluices must extend so far up the submerged river bed that the currents of the tributary floods reach it. A continuous current from each tributary to the sluices being thus established, the velocities would be considerably increased, and might be great enough not only to carry along the silt resulting from the erosion upstream of top-water level, but also to erode the banks of the ramblas below that level; that is, to excavate in the bed of the reservoir. The other explanation, which may be either alternative or supplementary to the first, is that when the water surface of the reservoir is considerably below top-water level there are sometimes floods of sufficient force to erode the beds of the tributaries below that level, carrying the spoil far enough towards the bed of the main stream for its removal by the under-tow set up by the sluices in the next flood. Though the effect of these sluices is unusual, it must not be overlooked that the conditions are also unusual. In some cases in which scouring sluices have been provided no attempt has been made to prevent silting up to a level which is considerably above the banks of the original stream. The deposition of silt up to this level may be desired for the sake of securing a water-tight foundation for a large dam. The sluices, drawing from a wide area, draw fanwise, and the scouring effect rapidly dies away with distance from the sluice. Again, in other cases, although the sluices are nearly at the old river bed level, it is a wide river, the head of water is small, and no very great velocity is imparted to the water. The case of large sluices drawing from a submerged river bed which is narrow compared with the widths at levels above it, the sluices discharging under a considerable head, differs in important respects from either of the other cases. A contributing factor is the relative smallness of the body of water in the reservoir, and others, presumably, the high velocity at which the tributaries discharge into it and the well-defined character of their beds when they were first submerged.

It is reported from Moscow that the construction of a great waterway between the Volga, the Don and the Sea of Azov has been decided upon. The work will, it is stated, cost 120,000,000 roubles, and this year the Government is granting 25,000,000 roubles for preliminary work. The construction of this waterway will considerably reduce the cost of transport of oil from Baku and Grozny, fish from Astrakhan, grain from the Volga and Kama districts, coal from the Donetz region and Persian goods.

THE CHANCY-POUGNY HYDRO-ELECTRIC POWER STATION

The Chancy-Pougny Hydro-electric Power Station.

THERE is nearing completion on the Rhone, a short distance below Geneva, a hydro-electric power station which presents many points of interest. The power is derived from the river by means of a barrage which provides a head that varies with the flow in the river from a maximum of about 9 m. to a minimum of about half that height. The flow of the river may vary from as much as 1500 cubic metres per second to as little—in very extreme cases—as 96 cubic metres per second; but the average flow, taken throughout the year, is about 310 cubic metres per second. The arrangements are such that the whole flow, up to a total of 450 cubic metres per second, can be passed through the turbines. The total horse-power, which will then be available in the form of electrical energy, will be some 38,000, and it is anticipated that the station will have an annual output of from 130,000,000 to 160,000,000 kilowatt-hours.

For the particulars of this station, which are given in what follows, we are indebted partly to two articles which appeared in two issues of our contemporary the *Bulletin Technique de la Suisse Romande*, partly to the "Proceedings" of the Société des Ingénieurs Civils de France, partly to information supplied by the makers of the machinery, and partly to La Banque Suisse des Chemins de fer.

The Chancy-Pougny central station—upstream and downstream views of which are given above—forms part of a comprehensive scheme for the general employment of the Rhone from the three points of view of (1) meeting the demands for irrigation put forward by agriculturalists; (2) improving navigation; and (3) utilising the potential power possessed by the waters of the river and its affluents in descending through a total height of 372 m., say, 1220ft., from the Lake of Geneva to the sea. The idea of erecting the station originated with a French-Swiss group, which was constituted as long ago as 1910 to take steps to obtain the required French and Swiss concessions and to acquire the necessary land. This group in 1911 parted with its rights to La Banque Suisse des Chemins de fer, of Basle, which, thereafter, continued the studies of the originators of the scheme. It will not be necessary to follow in detail either the investigations or the opposition which was met with, but it will suffice to say that the Swiss concession was obtained in December, 1917, and the French concession in May, 1918. It was necessary to obtain concessions from both countries since the river at the site of the barrage actually forms the frontier. The two concessions were subsequently made over to the Société des Force Motrices de Chancy-Pougny, which had been constituted to acquire them under the ægis of Les Etablissements Schneider et Cie. The *rôle* of consulting engineer and architect was entrusted to the Banque Suisse des Chemins de fer, which got out the scheme and made all the drawings for the whole installation and which worked in collaboration with the technical experts of Schneider et Cie., while the civil engineering work was allotted to the Société Générale d'Entreprises with which, for the construction of the actual barrage, was associated the firm of Locher et Cie., of Zurich. The Schneider firm undertook to supply the mechanical and electrical equipment.

Constructional work was begun in November, 1920, the position for the dam having been decided upon after lengthy investigations. The site eventually chosen is about 2 kiloms. above the bridge at Chancy, and near the confluence of the Couchefatte with the Rhone. The barrage—a plan of which is given in Fig. 1, while upstream and downstream views are given on page 328—extends across the full width of the river, and the combined area of the openings, other than those leading to the turbines, left for the passage of water has been calculated to permit of the easy passage of a flow of 1500 cubic metres per second. The portion of the barrage not taken up by the generating station has been given five openings, each 12 m. wide, four of these openings being furnished with Stoney sluices, 11 m. high, while the fifth is fitted with lock head gates, which, for the time being, are kept continually closed. Although a flow of 1500 cubic metres per second is, apparently, the heaviest which has ever been recorded, it is asserted that with the lock gates closed, with none of the turbines operating, and with one of the sluices out of order and closed, a flow of as much as 1800 cubic metres per second could be passed without any ill effects from rise in level of the water in the upper reaches. Drawings of the barrage are given in Figs. 2, 4 and 5. The piers which separate the sluice openings are 26 m. deep to the bottom of the foundations, 23.5 m. long and 3.5 m. wide. The foundations are sunk 2 m. into "molasse"—sandstone and calcareous conglomerates—to a depth 15 m. below ordinary low water level and 17 m. below ordinary high water level. They are constructed of reinforced concrete, with facings of undressed granite in the submerged portions, and with concrete blocks above water level. They are connected together well above the highest flood level by a bridge of reinforced concrete. The pier separating the lock opening from the sluice opening next to it is 7.5 m. wide, and contains the culverts for the filling of the lock, which, however, is not yet built.

The sluices are of the Stoney type, made in accordance with the patent of Buss, of Basle. They are in two parts, which can be manipulated independently of one another. The upper part, which is 3.5 m. deep and weighs 15 tons, can be lowered so as to be behind the lower portion in order to allow of the passage of floating bodies, especially ice. The lower part weighs 60 tons, and has a depth of 7.5 m. The winches, by means of which these sluices are manipulated, are arranged at a height of 16 m. above the bridge on a gantry, which also contains a conduit for the electric cables. The two sluices for each opening are actuated by one winch, which is driven by a 25 horse-power motor. With the winch revolving in one direction, the top portion of the sluice is first lowered for, say, a moderate flood; then, with the winch still revolving in the same direction, the two portions of the sluice—the upper portion resting on the lower—can both be lifted clear of the water. Each winch can exert a pull of 136 tons. The metallic portions of the sluices and their operating mechanism were supplied by Schnieder et Cie. and the Swiss firms of Buss of Basle and Roll of Berne.

The sill of each sluice opening is paved with blocks of granite, each about 1 cubic metre in size, and weighing, in consequence, more than 2 tons. These blocks, are bedded on and tied into the concrete by round iron rods 36 mm. in diameter. Furthermore, the blocks which come at the upper edge of the sill are protected with an armouring lip of steel plate 10 mm. thick. These precautions are essential for the satisfactory upkeep of the sills, because of the considerable forces, tending to erosion—brought about

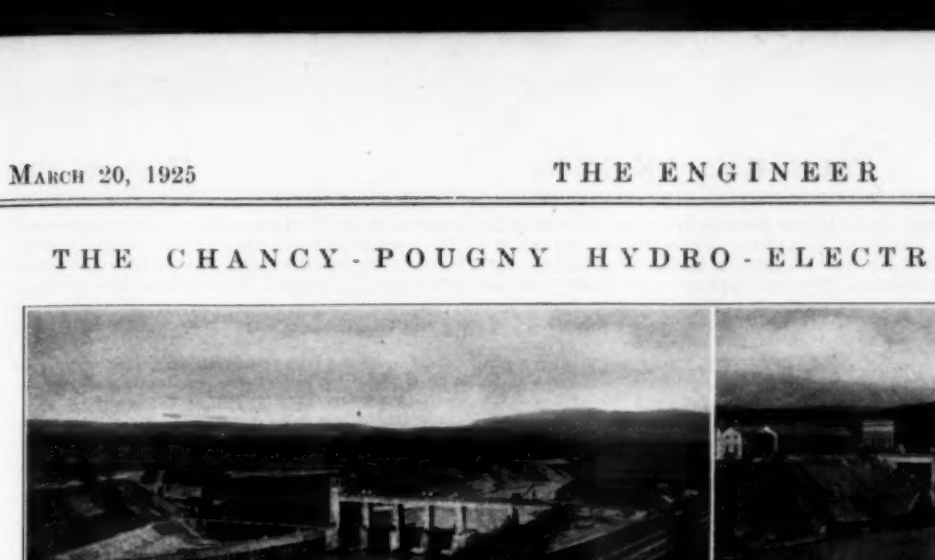


FIG. 1—PLAN OF THE CHANCY-POUGNY BARRAGE AND POWER STATION

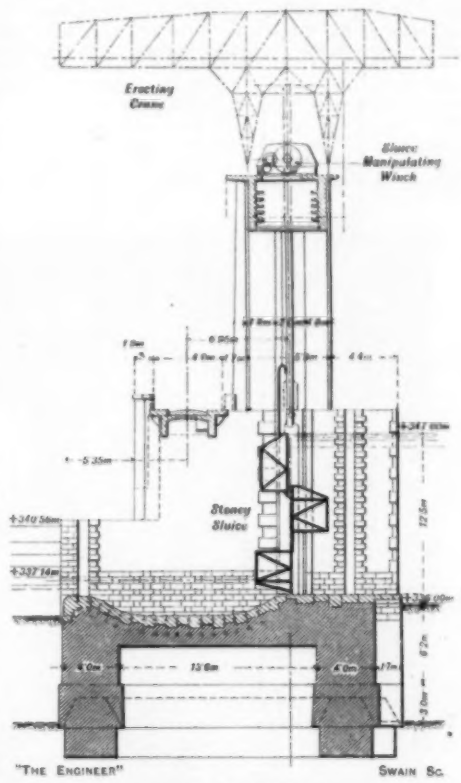


FIG. 2—CROSS SECTION OF BARRAGE AND SLUICE

by the rush of water and the large stones carried down by it—which they have to resist. In addition to the motion of the sluices referred to above, the type adopted permits of the reduction of the destructive forces of the water by operating both portions of the sluice at the same time in such a way that the water passing below the sluice breaks up the flow of that passing over the top, and *vice versâ*. It will be observed, too—see Fig. 2—that the sill below the sluice gates has been dished. This form was adopted after a long series of experiments made with a small-sized model by the Banque Suisse des Chemins de fer.

The water inlet arrangements will be seen in Fig. 1. They consist of a settling basin or forebay having a capacity of 5600 cubic metres—just under 1¼ million gallons—separated from the river by a screen of gratings with openings 22 cm. wide carried on eight piers placed at 14 m. centres and provided at the top with a service gangway on which is a mechanically operated rake for clearing away objects caught by the gratings. Within the screen, the settling basin or forebay is nearly triangular in shape with the apex upstream, at which point there is an entrance way for the passage of boats or pontoons, should it be necessary to employ them for maintaining the works or for dredgers for clearing the basin of silt. The water enters the turbine house along the base of the triangle, which is, of course, a prolongation of the barrage. In it there are five openings 11.6 m. wide and one opening 5.6 m. wide, separated by piers 2.9 m. wide—see Fig. 3. In order to reduce the size of the inlet sluices, each opening is divided into two by a central wall of reinforced concrete 0.4 m. thick. On either

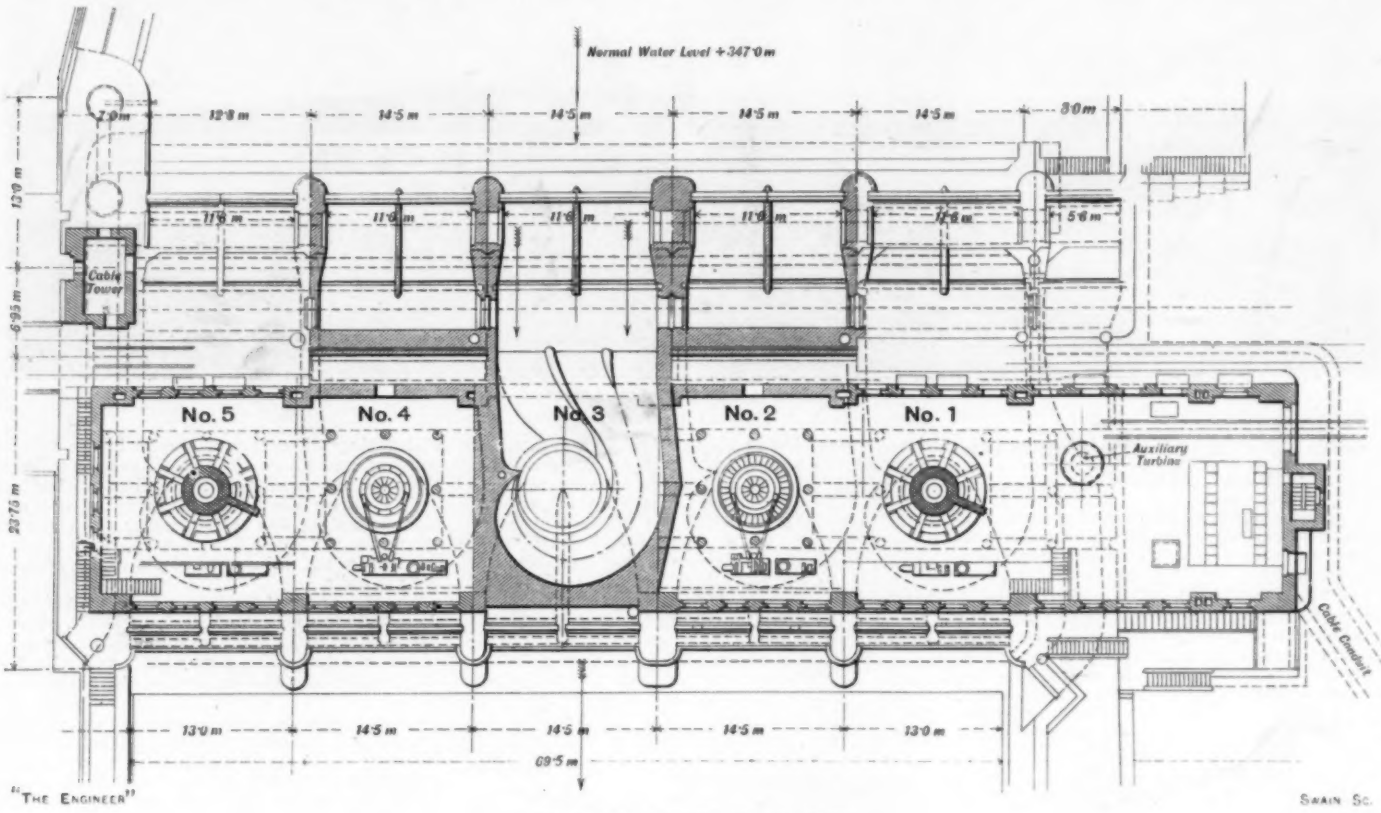


FIG. 3—PLAN OF THE POWER HOUSE

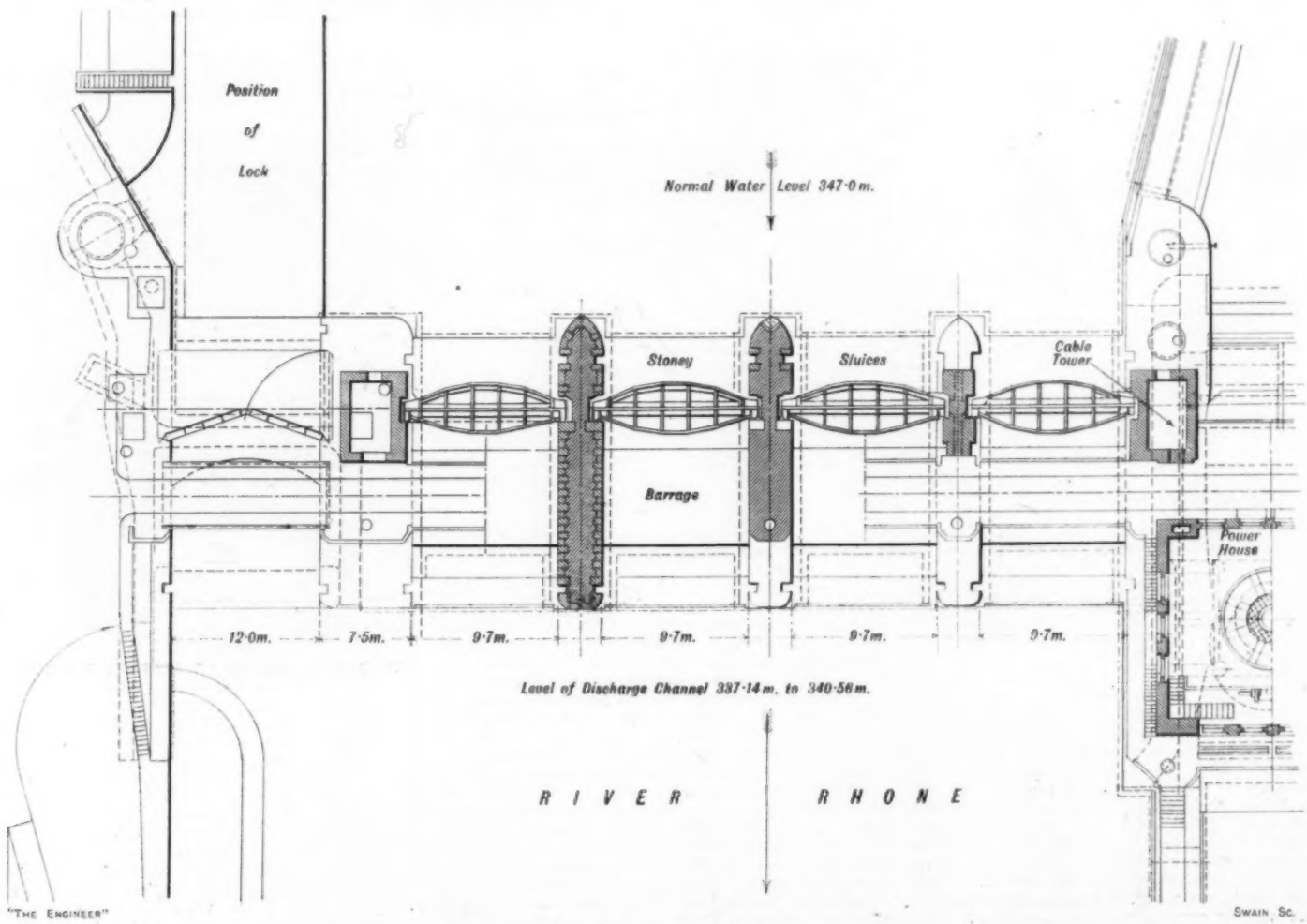


FIG. 4—PLAN OF THE BARRAGE

side of this wall there is a sluice gate 5.5 m. wide and 9.0 m. high. Each double opening supplies water to one turbine and is independent of the other openings. The section given in Fig. 6 shows the general arrangement of the inlets, flumes, turbine, &c. Below the sluice gates will be seen a culvert which runs right across from side to side of the intake. It is in communication with each turbine chamber through two segment-shaped valves 1 m. high and 5 m. wide and can discharge below the barrage. These valves permit of the complete emptying of each turbine chamber. On the downstream side of this drainage culvert there are gratings with openings 7 cm. wide and still further downstream there are

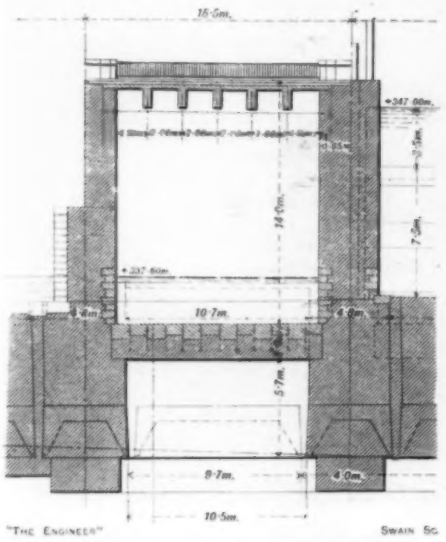


FIG. 5—SECTION THROUGH A SLUICE OPENING

what are termed compensation openings pierced through the piers so as to afford communication between two adjacent turbine chambers when their sluices are left open. The discharge channel below the power-house is separated from the river by an apron wall 80 m. long. It has a width of 69 m. and has been entirely excavated from the left bank of the river, the excavated bank being protected by a retaining wall which reaches a height of 10 m. at its highest point. The excavation was given a batter of 2 in 3 up to a point 30 m. above the retaining wall.

The generating station is a building 93.5 m.—say, 306ft. 9in.—long by 15.9 m.—say, 52ft. 2in.—wide. It is 41 m. high from the floor of the discharge passage

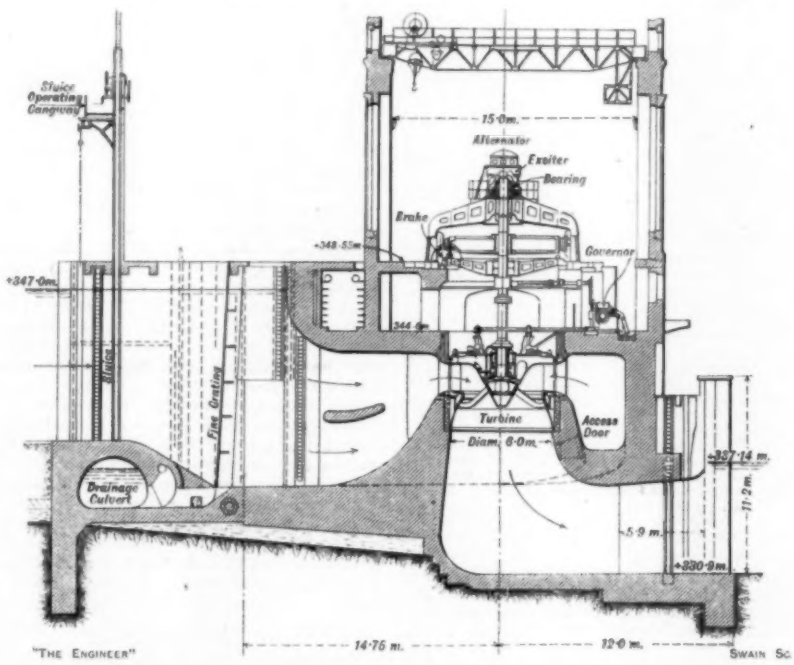


FIG. 6—SECTION THROUGH SLUICE, FLUMES AND TURBINE

to the topmost point of the roof. It contains five main turbines and one small turbine of 360 horse-power. Messrs. Escher Wyss, of Zurich, have supplied two of the large turbines and the auxiliary turbine, while the Etablissements Charmilles (formerly the Etablissements Piccard-Pictet), of Geneva, have supplied the remaining three large turbines. Many of the heavier parts of the turbines were made by Messrs. Schneider et Cie., while the runners for the five large turbines were made at the Skoda Works at Pilsen. These turbines are claimed to hold the record for power developed for their type, in comparison not only with any in Europe, but also with those in America, both with respect to their dimensions and the quantity of water which can pass through and also in consideration of their high specific speeds. The specific speed, it may be mentioned, varies under normal load from 510 to 530, while under minimum head it attains a value of 570. The machines are of the single runner Francis type with vertical spindles. The actual form of the runners in the Escher-Wyss turbines—see Figs. 7 and 8—is different in several respects from that of the Charmilles turbine runners.

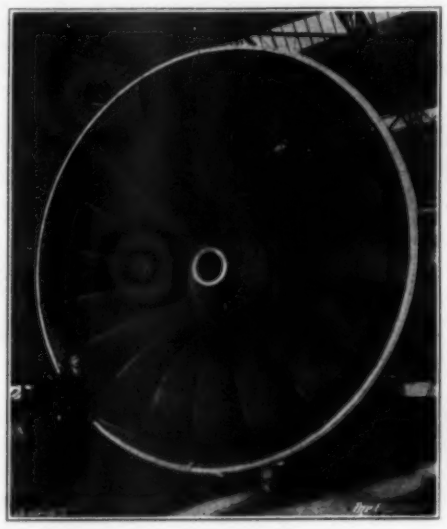


FIG. 7—UNDER SIDE OF TURBINE RUNNER

The former have an outside diameter of 5.36 m.—say, 17ft. 7in.—and each weighs 21,960 kilos., or 21.6 tons. The wheels are in two parts, half the total number of the blades, half the boss, and half the ring being cast in to both, and each wheel has eighteen blades. The outer ring is of cast steel having a tensile strength of from 45 kilos. to 55 kilos. to the square millimetre with an elongation of from 15 to 12 per cent. The blades are drop forged and are made of sheet steel with a tensile strength of from 48 kilos. to 53 kilos. per square millimetre and an elongation of 20 per cent. The Charmilles runners are slightly larger, being 5.5 m. in diameter and weighing 25,910 kilos. each, but they only have twelve blades. As in the Escher-Wyss turbines, the runners are in two parts, and the half ring, half boss and half the total number of blades are in one piece in each case. The tensile strength of the cast steel in the rim is from 50 kilos. to 60 kilos. per square millimetre, with an elongation of from 19 to 14, while the metal of the blades is the same as that in the Escher-Wyss turbines, but it is 25 mm. thick.

Each of these five turbines is intended to develop 7600 metric horse-power at a speed of 83 revolutions per minute with a head of 8.16 m.—26.77ft.—and 8700 metric horse-power under a net head of 8.87 m. when passing 92 cubic metres of water per second. The control of the turbines is effected in the usual way by a ring of movable vanes surrounding the runners, all the control gear being fixed well above the water. The vanes are actuated by the ordinary arrangement of levers and links which are operated by a servo-motor worked by oil under pressure, which regulates the vane openings in accordance with the speed of the runners.

Each turbine is, as has been said, placed in a separate concrete chamber. The spiral of the latter does not measure less at its inlet end than 12.5 m. wide by 7.65 m. deep; that is to say, the inlet has an area of approximately 96 square metres—or rather over 1033 square feet. The discharge flume measures 12 m. wide by 5.4 m., or an area of 65 square metres. A dividing wall carried from floor to ceiling separates the opening into two. The exact form to give to the inlet and discharge flumes, as well as the best shape to give the runner blades, formed the subject of

FIG. 8—TOP SIDE OF TURBINE RUNNER

numerous carefully conducted investigations carried out by both turbine builders with model machines. In the case of the Charmilles firm the model employed was one-seventh the size which it was proposed to make the final machine, and the flumes were made of sheet steel. It is somewhat curious that the two makers should have evolved two wheels which are to develop the same powers, which are of very nearly the same diameter and are intended to revolve at the same speed, but which, nevertheless, so far differ from one another in that one has half as many blades again as are possessed by the other.

As each of the turbines can, with an average head of 8.16 m., develop 7600 horse-power, it follows that when all five are in full operation a total of 38,000

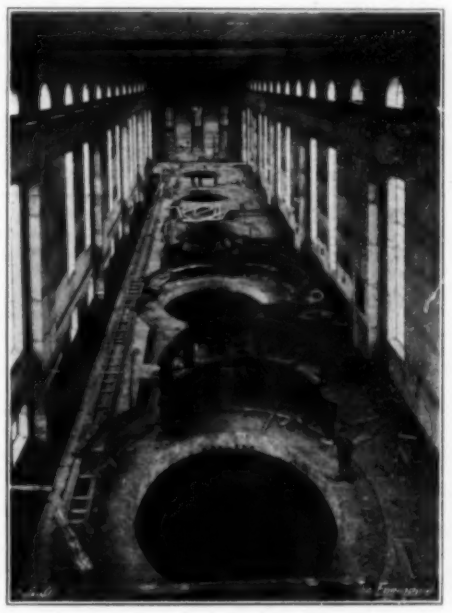


FIG. 9—VIEW ALONG TURBINE ROOM

horse-power would be developed. As a matter of fact, it will be by no means possible to obtain that amount of power continuously, since it would require a flow of some 450 cubic metres per second to produce it, which volume, it is estimated, will only be coming down stream during from 90 to 150 days in the year. The average flow of the river is, as already mentioned, given as 310 cubic metres per second, and that volume, with a mean head of 8.16 m. would yield just over 33,000 theoretical horse-power. Occasionally, though apparently very rarely, the flow falls as low as 96 cubic metres per second, and at such times the available head is 9 m., or rather under. A flow of that volume can be passed through one of the turbines, which would yield then approximately 8700 horse-power. Ordinarily, however, the flow does not fall

below 110 cubic metres per second, when the yield will be something over 10,000 horse-power.

Each of the large turbines is directly connected to an 11,000-volt, 50-period, three-phase, 7000 kVA alternator, made by Messrs. Schneider and Co. in their works at Champagne-sur-Seine. Interior views of the generator room before and during the erection of the alternators are given in Figs. 9 and 10. Each machine has its own separate exciter on the same shaft. The total weight of each alternator is 200 tons. Having regard to the great weight of the moving portions of the turbines and generators and of the hydraulic thrust on the runner—and it is estimated that the total load may amount to as much as 230 tonnes—specially designed bearings had to be provided. The upper bearing, which rests on the spider above the alternator, is furnished with blocks, which are capable of movement, and are so arranged that when the shaft turns, thin films of oil can pass between the surfaces in contact. There is no oil pump, the oil being supplied to the bearing from a reservoir above the bearing. In order to ensure quick stopping of the runner and rotor, there is fitted on the lower side of the latter a ring of soft iron, on which can be made to impinge eight brake shoes arranged at regular intervals round the periphery. The servo-motors which actuate these shoes and which are fixed to the spider that supports the lower bearing of the alternator are operated by oil under pressure obtained from the vane-control pipes. This braking arrangement is made by the addition of a simple mechanism to act as a lifting jack to raise the motor. All the servo-motors of the regulators are coupled up together, as in a central pumping station, in such a way that if at any time one of them is put out of action, the supply of oil will be supplied by the others.

As mentioned above, there is, in addition to the five main turbines, a smaller machine which gives 365 horse-power at 375 revolutions per minute. It drives directly a vertical spindle electric generator, which is intended to supply current for, among other things, the operation of the sluice actuating winches, the overhead cranes and lighting should the main units be shut down.

The whole of the electrical equipment, in addition to the generators, and including the switchgear and the necessary apparatus for increasing the generated pressure of 11,000 to 120,000, which is the voltage used for transmission, was supplied by Messrs. Schneiders. The switchgear, &c., is quite separate from the power house, and is erected on the French bank of the river. The current is taken from the machines in single cables, which pass over the barrage in a conduit as already explained, being taken up to the conduit through a tower. There are three groups of three transformers, each of 4700 kVA capacity, which are installed in the open air—see Fig. 11. After transformation, the current is transmitted by overhead cables to the Creusot Works, 160 kiloms. distant.

The facts that the barrage is traversed by the international frontier line and that all the generating station and part of the barrage are in Switzerland, while the remainder of the barrage is in France, led to some rather curious situations. The railway station at which the machinery, &c., arrived is at Pougny, a French village, about 3½ kiloms. from the site of the barrage. The stores, workshops, &c., could only be erected on the Swiss side of the river. The French material received at Pougny and destined for the French portion of the works had to be taken into Switzerland, in bond, so to speak, and deposited in the stores before being used, while the material destined to be used in Swiss territory had to pay customs dues! French and Swiss customs officers who lived on the site saw to it that nothing traversed the frontier in one direction or the other without a permit or without paying the necessary dues. For certain classes of material an arrangement was come to by which payment was made each month in accordance with the figures shown in the stores books. The fact that the works were astride the frontier also led to difficulties in paying the artificers, some of which had to be paid in French and some in Swiss money. In the working out of what was due to them, account had to be taken of the influence of the rate of exchange on the cost of life in the frontier zone. Added to the foregoing the laws regarding the compensation of workmen are not the same in the two countries. However, these obstacles were satisfactorily surmounted, and the plant was sufficiently far advanced for two of the main generators to be got into position in November last. The smaller auxiliary machine has since been erected, while the step-up transformer station has been completed. It was hoped to begin to supply current on March 1st. The remaining three main units will be installed during the coming summer.

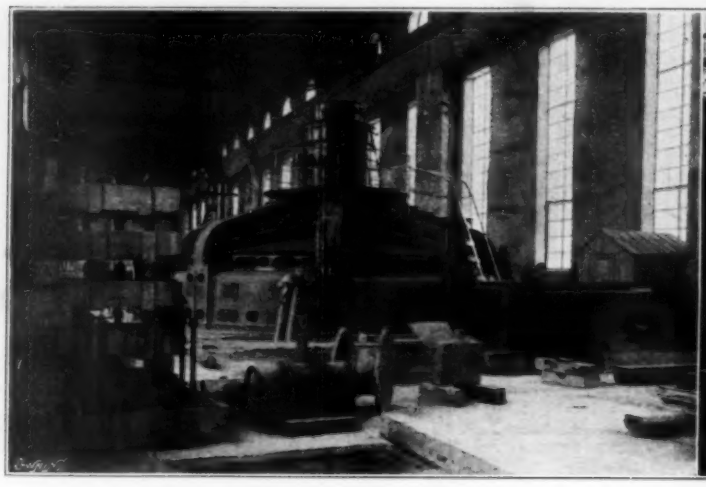


FIG. 10—INTERIOR OF GENERATOR ROOM

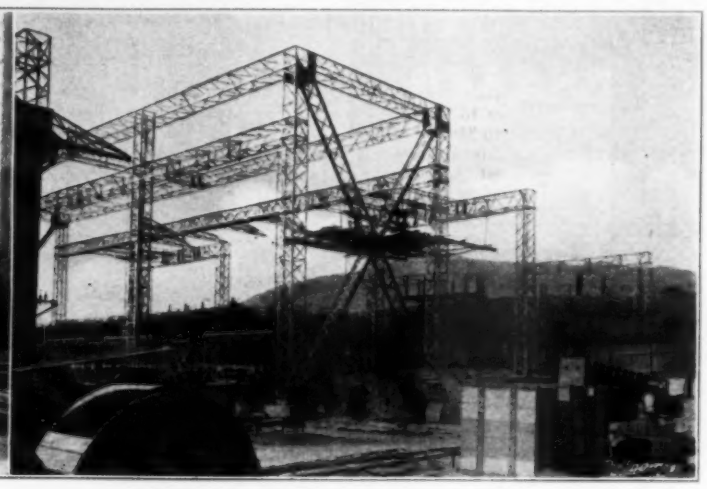


FIG. 11—OPEN AIR TRANSFORMER STATION

Institute of Metals.

No. II.*

At the afternoon session of the meeting on March 11th, which was presided over by Professor Thomas Turner, there was an interesting discussion on a paper by Mr. T. G. Bamford, dealing with "Comparative Tests on Some Varieties of Commercial Copper Rod."

COMMERCIAL COPPER ROD.

The primary object of the research was to compare the properties of certain distinctive varieties of commercial copper, with a view to ascertaining their relative durability under conditions which they would meet in service, particularly as constructional parts of locomotive fire-boxes. Three deoxidised and two "tough-pitch" coppers were tested. Of the former, the first contained 0.31 per cent., the second 0.53 per cent. of arsenic, while the third contained 1.5 per cent. of nickel, and only a trace of arsenic. Of the "tough-pitch" copper, one contained a trace of arsenic, while the other contained 0.45 per cent. of this element. It was found that the phosphorus present in commercial copper which has been deoxidised with this element does not impair the mechanical properties of the metal. Three lots containing up to 0.2 per cent. of phosphorus were extremely strong, quite ductile and more resistant to alternating stresses than "tough-pitch" varieties, which were free from phosphorus. Deoxidised low arsenical, high arsenical and 1.5 per cent. nickel-copper containing up to 0.014 per cent. of oxygen withstand severe gassing treatment, which would ruin "tough-pitch" metal. Deoxidised copper containing 1.5 per cent. of nickel, is more resistive to harmful influences arising from severe heating in either reducing or oxidising atmospheres than are either "tough-pitch" (arsenical or non-arsenical) or deoxidised arsenical coppers. Actually, the tensile strength of this nickel-copper is vastly improved, its hardness greatly increased, no brittleness is developed, and it preserves a high ductility after severe gassing treatment. The nickel-copper containing 1.5 per cent. metal oxidises less rapidly than any other variety tested. The "tough pitch" and the deoxidised varieties, not containing nickel, oxidise approximately to the same extent, but when the "tough-pitch" varieties scale the oxide penetrates into the metal—more particularly in the case of non-arsenical "tough-pitch" copper, on which a very rigidly adherent scale is formed. It follows that "tough-pitch," non-arsenical copper will give most trouble in hot working operations where it is desired to avoid entanglement of scale in the metal. The resistance which 1.5 per cent. nickel-copper possesses to gassing, as well as its augmented hardness and strength resulting from high-temperature treatment, render it very suitable for engineering, and particularly for locomotive parts.

Mr. F. Tomlinson said that if tough pitch copper was heated in a reducing flame, gassing took place, but with deoxidised copper, experience showed that the risk of gassing was greatly diminished. The difficulty from the commercial standpoint was how to apply this knowledge. For fire-box plates the great majority of locomotive engineers, quite 95 per cent., preferred to use tough pitch copper containing a certain amount of arsenic. One reason for this choice might be that fire-box temperatures were never high enough for gassing to take place. The points raised by the author, although they might not be very important to users, must receive serious consideration from manufacturers of copper. It was suggested that engineers should use copper containing from 1 to 2 per cent. of nickel, or even higher percentages, but there was very little difference between that material and tough pitch copper, and users appeared to prefer the latter. From the manufacturing standpoint, it was an advantage that tough pitch copper could be controlled in large quantities, and produced of a consistent quality. This consistency made a definite appeal to engineers.

Mr. A. J. G. Smout expressed much interest in the conclusions drawn as to the effect of the addition of 1.5 per cent. of nickel to a properly deoxidised copper. It was a significant fact that this copper should be more resistant than other varieties of the metal to the usual harmful effects of exposure to reducing gases at high temperatures. Nickel copper had been used with advantage in the fire zone portions of locomotive fire-boxes where the material was very severely tested. Mr. Tomlinson's comments had not perhaps been quite fair to the author, as, although gassing in fire-box material was only rarely met with in practice, that was not the only thing which counted. The paper brought out the greater hardness and strength of the nickel-copper alloy. He hoped Mr. Bamford would, before the paper was printed in the "Transactions" of the Institute, give particulars of experiments at higher temperatures than those recorded in his contribution.

Dr. H. Moore welcomed the paper as an important addition to practical knowledge of the subject dealt with. The advantages of using the 1.5 per cent. nickel copper were not sufficiently realised by engineers, and indeed the whole question of the employment of deoxidised copper was misunderstood by many people.

Mr. W. A. Ballard, referring to the statement that fire-box temperatures were not high enough to require a change from the general use of tough pitch copper, said that some portions of the fire-box plate were subjected to extreme temperatures at times, and the burning out of the ends of copper tubes was not uncommon. One reason why the manufacturer preferred to supply tough pitch copper rather than the deoxidised varieties was that the latter was more expensive to make, and was more difficult to handle in the railway workshops. A somewhat surprising fact brought out in the paper was that, contrary to what had been hitherto believed, deoxidised copper did not scale less than tough pitch.

Mr. Williams said that the value of the paper rested on the original samples taken, and he could not accept the author's figures as definite enough to possess the value he assigned to them. The figure given for the oxygen content seemed inexplicable.

Mr. Bamford dealt with one or two of the points raised in the discussion, and will reply more fully by correspondence. With regard to the oxygen content, it was, he said, known that copper containing oxygen could be gassed, but the percentage of oxygen associated with that effect had not been determined. Sir Henry Fowler had put the percentage at .015, but the work described in the paper showed that copper containing that percentage of oxygen would not be subjected to any serious trouble from gassing. On the locomotive fire-box question, there was a prospect of steel replacing copper, and any light which could be thrown on the behaviour of copper would be of value. He would be glad to make additional tests if he could obtain more samples.

A contribution on "The Influence of Lead and Tin on the Brittle Ranges of Brass" was submitted by Dr. Denis Bunting.

THE BRITTLE RANGES OF BRASS.

The influence of two impurities, lead and tin, on the brittle ranges of brass has been investigated. It was found that the chief effect of lead was mechanical; the brittle range in itself was not affected, but masked owing to the embrittling effect at other temperatures of the lead which segregated as globules to the grain boundary. β brass was very susceptible to this deleterious effect; $\alpha + \beta$ brass was also affected, but not to the same extent, whilst α brass appeared to be immune from this

* No. I. appeared March 13th.

intercrystalline weakness caused by small percentages of lead. The effect of tin could be considered under two headings: tin in solution and tin in excess of the solubility limit. Tin in excess of the solubility limit produced extreme brittleness owing to the production of the brittle gamma or delta constituent. The effect of tin in solution appeared to be connected with an increase in crystal rigidity. The β and $\alpha + \beta$ (β matrix) brasses were rendered more brittle at low temperatures, and the brittle range so increased, whilst the impact strength of the α and $\alpha + \beta$ (α matrix) brasses was improved, and the brittle range was consequently decreased.

Mr. J. Jones gave a brief account of the work, allied to that described in the paper, which Dr. Greaves and he had carried out at Woolwich. Tests with a great variety of materials, including a number of brasses, had been made with the object of determining the effect of temperature on the notched bar impact value. The range of brasses was not the same as that selected for Dr. Bunting's experiments. The lead content in the samples tested at Woolwich was lower than the highest limit in Dr. Bunting's specimens. In the 70 : 30 brass, with ½ per cent. of lead, the impact value of the notched bar dropped from atmospheric temperature up to 200 deg. Cent., and fell rapidly from that point to 350 deg. Cent., at which temperature the impact figure was very low and did not recover as the temperature was raised. With .1 per cent. of lead the behaviour of the material was almost identical. With only a trace of lead in the material, there was a gradual drop in the impact figure up to 650 deg. Cent., and at higher temperatures a steady rise up to a maximum at 800 deg. Cent., and then a rapid fall as the melting-point of the metal was approached.

Dr. Bunting said that the line of research now being followed up was to ascertain the effect of cold work and annealing, and the influence of impurities on the properties of the material.

Mr. G. L. Bailey presented a paper by himself and Mr. R. Genders on "The Alpha Phase Boundary in the Copper-zinc System."

THE COPPER ZINC SYSTEM.

In view of evidence indicating inaccuracies in the position of the alpha phase boundary as given by Shepherd and modified by Matthewson and Davidson and others, the authors undertook complete revision of this portion of the diagram. The method adopted was that of quenching the alloys, after annealing to equilibrium, at successive intervals of 20 deg. Cent. in the neighbourhood of the phase boundary. Subsequent microexamination was made to determine the lowest temperature at which traces of beta appeared, and these temperatures were determined over the range 61.1 to 67.7 per cent. copper on seven alloys at intervals of approximately 1 per cent. copper. The preliminary annealing of the alloys to all alpha presented no difficulty where the copper content exceeded 62 per cent., but the long annealing required for alloys of lower copper content was avoided by first quenching the specimens in the beta range and re-annealing at 450 deg. Cent., at which temperature equilibrium was reached within a short period, one hour in the case of the 61.1 per cent. alloy. The data obtained from this work require a movement in the solubility line to the right of that given by previous workers. At 470 deg. Cent. the boundary reached a low limit of concentration of copper at approximately 61 per cent., and this figure seems to be unaffected to any appreciable extent by further fall in temperature. Above 470 deg. Cent. the solubility decreased with rise in temperature and the junction of the alpha boundary with the solidus was shown at a concentration of 67.5 per cent. at a temperature in good agreement with Parravane's determination of the peritectic temperature at 905 deg. Cent. The commencement of the peritectic transformation at 67.5 per cent. copper was confirmed by a determination of the solidus for an alloy containing 70 per cent. copper, which first showed traces of liquid at about 913 deg. Cent.

Dr. Marie Gaylor referred to her recent work on the determination of the solubility of alpha, beta and gamma constituents. The method employed was that of annealing the specimens at a high temperature and then slowly cooling over a period of several days down to the quenching temperature. The variation between the values obtained in the two sets of experiments was extraordinarily small, although the methods adopted were entirely different.

Dr. W. Rosenhain said that papers had frequently been produced dealing with a complicated alloy system on the basis of less work than had been done in this case on a single line of the diagram. He commended the authors for concentrating their efforts in that way. A general review was almost valueless.

Mr. Bailey, in a short reply to the discussion, expressed the hope that the work of the authors would bring about a shortening of the time required for investigations of the kind, and that perhaps it could be extended to other work.

A paper by Mr. E. A. Bolton, entitled "The Removal of Red Stains from Brass," was then briefly presented by the author. A synopsis of the contents is given below.

THE REMOVAL OF RED STAINS FROM BRASS.

Various considerations affecting the oxidation and staining of brass are reviewed and the author's earlier work is confirmed, and, in addition, the difficulty of avoiding staining with brass of high copper content is described. The theory of staining occurring by reaction between cupric oxide and the pickling acid is described and attributed to concentration cell action. Electrochemical difficulties in stain removal are shown. Attention is turned to the use of solutions containing sulphuric and nitric acids for stain removal. While such solutions show some possibility of success, results are not so favourable as those obtained with solutions of dichromate and sulphuric acid. The action of these solutions is explained and described in detail, and as a result of the research details are given suitable for the development of the process upon the industrial scale.

Dr. W. H. Vernon commended the work of the author in dealing with an actual commercial problem. The research was not one which gave an opportunity for accurate scientific study, and the author was therefore to be congratulated on the amount of data he had succeeded in collecting. The difficulty of preventing the staining of brass of high copper content was recognised. With regard to the sulphuric nitrate solution, perhaps the author could say what would be the effect of the addition of a small quantity of hydrochloric acid. The author had supplied in his account of the effect of dichromate and sulphuric acid solutions information which should prove very useful in works practice.

Dr. Brownsdon, while praising the work done, disagreed with the author from the chemical standpoint in regard to the solutions used. Nor should it be overlooked, he reminded the meeting, that for some requirements the red stain was popular with users. It had been found in the case of material for the radiators of motor cars that the metal with the red stain had good soldering properties.

Mr. A. J. Smout said that the author had done valuable work in connection with works problems during the past two or three years, which had enabled manufacturers to put a better product on the market. That was no mean achievement. With regard to the red stain, it was not met with nearly so frequently now as ten years ago.

Professor Thomas Turner, who spoke from knowledge of Mr. Bolton's work from the beginning, said that the red stain problem went back for many years. He himself had begun the study of it forty years ago, but it was only then possible to make broad generalisations on the subject. It was recognised that prevention in this case was better than cure. Red stain was becoming more rare, and Mr. Bolton's remedy was intended to cover the period until means of preventing the formation of red stains in brass could be worked out.

At the concluding session of the Conference on March 12th, the chief discussion was on a paper by Mr. G. L. Bailey and Mr. R. Genders, dealing with "The Density and Constitution of the Industrial Brasses."

INDUSTRIAL BRASSES.

Values have been obtained for the crystal density of the brasses in equilibrium over the range of composition used industrially. The effect of coring in α brasses on the net density appears to be negligible; the alloys which contain β in the chill-cast state, however, have a small range of variable density owing to the difference in density between α, and β and the density of sound castings may vary according to the amount of β produced by the particular conditions under which the alloy was cooled from the liquid state to temperatures within the region of 450 deg. Cent. An alloy always consisting entirely of β is unaffected in density by heat treatment, and it is apparent that whatever the nature of the transformation at 470 deg. Cent., either there is no accompanying volume change or the transformation is not suppressed by any ordinary method of quenching. The differences which have been observed by Bamford and other workers between the densities of sand and chill castings are considered to be due to the presence in the sand castings of fine porosity consisting of interdendrital cavities. A phenomenon not previously observed by the authors in any alloy, consisting in a reduction of density, due to unsoundness accompanying constitutional change (β to α), has been found to occur in the brasses over a considerable range of composition. The unsoundness produced is removable either by reversing the constitutional change (as by quenching) or by mechanical compression. From a practical point of view it is of particular interest that heat treatments, involving quenching of the $\alpha\,\beta$ brasses and a small range of the α brasses, may give rise to internal stresses of considerable magnitude, consequent on constitutional changes taking place during quenching. The cracking of heat-treated articles which sometimes occurs appears to be attributable to constitutional volume change rather than to the difference between the expansivities of the different constituents.

Dr. Rosenhain regarded the contribution as one of considerable interest. His objection to the method adopted was that the samples of the authors required rolling. He thought it would have been preferable to have used material on which that work was not necessary. To state that changes in density were due to the closing up of cavities in the metal looked rather like an assumption of what the authors were seeking to prove. Nothing had been said in the paper as to the effect of grain size, but that would be very small, and perhaps not measurable. The remarkable fact brought out by the work described was the change in density due to the formation of alpha in the solid, and that point called for further investigation. The subject of the density of metals was assuming greater importance.

Professor Turner bore tribute to the useful work done by the authors. Methods of casting had an effect on the density of metals. Differences in temperature of pouring and rate of cooling would cause changes in density up to 7½ per cent. The manufacturer could employ density determinations as a test of the character of the material, the difference in density between good and bad metal being very marked. Some experiments were now in progress at Birmingham University by Mr. Bryant, of which he hoped details would be available in due course, on the question of coring and inverse segregation. In the zinc rich end of the series, which was being tested segregation was very evident in metals which had been rapidly cooled, whereas in the alloys dealt with in the paper before the meeting, there was no sign whatever of inverse segregation, whatever the rate of cooling or the mass of the metal. A point had now been reached where it was possible to say what should be the density of slowly cast alloys. As to the effect of closing up pores in the metal, that was a subject which was not so important in practice as might appear from a casual examination.

Dr. H. Moore thought it was necessary to know the degree of soundness of the alloy in the first place, and the only practical way of obtaining that knowledge was to apply a certain amount of cold work and take the density afterwards. The effect of cold work was very slight unless a considerable amount was employed. The character of the rolling in the case of the authors' samples would be without appreciable effect on the density of the material.

Dr. Rosenhain challenged the statement of Dr. Moore, and expressed the opinion that the point would have to be reconsidered. The effect of cold rolling was progressive, and the subject required careful investigation.

Dr. S. W. Smith said it would be generally agreed that for density determinations, cast material was not satisfactory. Rolling effects were difficult to determine. He had experimented with the rolling to different thicknesses of 70 : 30 brass. An examination of the results revealed the influence of slight variations in the copper content. If these results had any meaning at all, it was that after a certain degree of cold rolling the change in density could be remedied by annealing, but that after a limiting figure for rolling was reached, annealing did not restore the original density.

Mr. Genders replied briefly to the points raised. He could not agree with the criticisms of Dr. Rosenhain that the castings used were unsuitable material. The ingots supplied for the experiments were sound, and it was only in the interests of accuracy that a small amount of cold rolling was applied. The work was designed to explain, if possible, why changes in density occurred, but no results of real importance had yet been achieved.

Professor Turner, in winding up the discussion, said that from the commercial standpoint only changes in the first place of decimals were of importance. The effect of cold work only affected figures of the third place.

Mr. A. L. Norbury then presented a short contribution on "The Effect of Certain Elements on the Electrical Resistivity of Copper."

THE ELECTRICAL RESISTIVITY OF COPPER.

In the first part of the note some new data are given for the electrical resistivities of certain alloys of copper containing low percentages of each of the following added elements in solid solution :—Aluminium, silicon, manganese, nickel, zinc, silver and tin. From these results and from those obtained by previous investigators values for the "increase in the electrical resistivity of copper due to the presence in solid solution of 1.0 atomic per cent. added element" are calculated for each of the added elements. The results so obtained show that the "atomic effects" are small for elements like silver and gold—which are in the same group as copper in the periodic table—and are progressively larger as the added elements are further away from copper in the table. It is suggested, therefore, that the "atomic effects" are large or small according as the "affinity" between atoms of solvent and solute is large or small.

Professor Turner said it was a curious thing, if zinc and cadmium had the same effect, why the latter was preferred as an added element in some cases, of which copper for trolley wire was an example.

Mr. Norbury said it was a question of the hardening effect of cadmium.

A short contribution on "The Density of Rhodium" was given by Sir Thomas Kirke Rose.

THE DENSITY OF RHODIUM.

Two specimens of rhodium were kindly prepared by Messrs. Johnson and Matthey for the purposes of the investigation, one being forged up from sponge and annealed but not melted, and the other melted from sponge in the oxy-hydrogen blow-pipe and forged while hot. The rhodium sponge was chemically pure. The density of the melted specimen was found to be 12.47 in vacuo at 0 deg. to 4 deg., but the other specimen was evidently not free from internal cavities as its density was only 12.22. Previous determinations by other observers had given 12.1 to 12.6, but were unsatisfactory owing to various causes.

Dr. Rosenhain said that the task undertaken by the author was to some extent the outcome of work in connection with the preparation of the international critical tables. The information concerning rhodium would fill a gap in the information at present available. His only comment on the results of the work was that the X-ray method of determining density gave more accurate results than any experimental work.

Dr. C. H. Desch commented on the extraordinary difficulty of obtaining accurate figures for density values. Different observers, although themselves recording consistent results, were at variance with each other. One trained worker would differ from another, not only in the third, but sometimes in the second significant figure. Part of the trouble arose from the large quantity of gases present in the metals supplied. The gases were not in solution, but were in minute cavities. He agreed that the most accurate results were obtained by the X-ray method; at least, in the case of pure metals, but it was not so trustworthy when alloys were being examined.

In the absence of the author, Dr. Marie Gaylor introduced a paper by Professor Tomimatu Isihara on "The Equilibrium Diagram of the Aluminium-zinc System."

THE ALUMINIUM-ZINC SYSTEM.

The results of an investigation on the equilibrium diagram of the aluminium-zinc system are given by Professor T. Isihara, of Sendai, Japan. The research was undertaken to determine a correct equilibrium diagram by means of the electric resistance method. Microscopical investigation, the dilatometric method and X-ray analysis were used supplementarily.

In a comment on the results given, Dr. Gaylor said they confirmed the work which had been done in England on the same subject.

Dr. Rosenhain admitted the interest of the paper, but emphasised the fact that it only confirmed the work on the equilibrium diagram of the aluminium-zinc system, which stood to the credit of British workers, and that no claim for originality could, or should, be made. The task of determining this diagram had not only been arduous, but had required

great insight and skill. The task of confirming the results was in comparison much more simple.

Dr. C. H. Desch asked for additional information as to the change between 340 deg. and 350 deg. Cent. which had been compared to the A_2 change in iron, which was, however marked by a definite alteration in the magnetic properties of the material. In the aluminium-zinc system, non-magnetic materials were being dealt with, and that made a difference. He assumed that the change between the temperatures referred to was real, and was not due to the experimental method employed.

The last paper on the agenda was an account of "Some Experiments on the Abrasion of Metals," by Professor K. Honda and Professor R. Yamada, which, in the absence of the authors, was taken as read.

THE ABRASION OF METALS.

The amount of wear under different frictional horse-power and under different coefficients of friction was measured with respect to soft metals and carbon steels. In these metals the amount of wear is proportional to the frictional horse-power, provided that the coefficient of friction is constant. Under a constant frictional horse-power the amount of wear of these metals and steels increases with the coefficient of friction. The effect of the velocity of abrasion on the amount of wear is negligibly small in the range of velocity investigated.

Professor Turner said that the subject was of considerable importance, and an allied branch of the subject was being carried out by the British Non-ferrous Metals Association.

Dr. Desch said that this work, which was being conducted at Sheffield, was confined to a consideration of abrasive materials.

The meeting concluded with a vote of thanks to the Institution of Mechanical Engineers for facilities given for the holding of the meeting.

The Marine and Small Craft Exhibition.

The third Marine and Small Craft Exhibition and Congress, with which this year is incorporated the Holidays, Sports and Pastimes Exhibition, was opened at the Royal Agricultural Hall on Wednesday morning last, the 18th inst. Last year the Exhibition was held for one week only, but so great was its success that this year the promoters have decided that the Exhibition shall remain open until Saturday, April 4th. The number of firms exhibiting is, if anything, larger than last year, this being perhaps more noticeable in the sports than the yachting and engineering sections, but the main appeal is again made to the lovers of yachting and boating. Several fine examples of fully rigged sea-going yachts and cruisers are staged, and there is a wide selection of smaller launches and dinghies. Morgan Giles, Ld., of Teignmouth, Devon, are showing a 7-ton auxiliary cruising yacht, yawl-rigged, with a two-cylinder Ailsa Craig Kid Junior motor, fitted with reversing and speed-reducing gear. Other exhibits on this firm's stand include a National 14ft. centre-board class boat, a yacht's motor pinnace and dinghy, and a variety of special boat fittings. Cole and Wiggins, Ld., of 6 to 8, Lime-street-square, London, and Leigh-on-Sea, display two fine examples of sailing boats for estuary work and a 26ft. motor cruiser, specially designed and equipped for long-distance work. Other sailing boats and yachts are to be seen on the stands of David Hillyard, of Littlehampton, and the Snowden Boat Company, of 40–44, Holborn-viaduct, E.C. 1.

Turning to motor cruisers, a most interesting exhibit is a 28ft. sea-going cabin cruiser, shown by the Walton-on-Thames Launch Company, which is fitted with a single-cylinder Petter cold-starting marine oil engine, designed for an output of from 8 to 10 brake horse-power when running at 600 revolutions per minute. The engine is neatly housed in a space leading to the main cabin accommodation, and is directly coupled to a Duerr type reversible propeller, operated by a single control lever at the helmsman's platform. The makers claim that the use of a heavy slow-speed oil engine will considerably reduce the initial cost of the machinery and show a large saving in the fuel cost. The patented starting cartridge, which enables the engine to start from the cold, is also a considerable advantage in yachting work, and we learn that this type of engine is finding increasing favour for coastal boats and fishing craft. A twin-cylinder 24–28 brake horse-power Petter marine engine of the same type, fitted with a Langdon reversing gear, is also shown.

On the stand of S. E. Saunders, Ld., of Bush House, London, and East Cowes, we noted a 30ft. fast runabout launch, built of "Consuta" sewn plywood and highly finished. An interesting part of the propelling machinery is the firm's patented lifting gear for the propeller and rudder, which enables the launch to be used in shallow waters and river estuaries. A specially designed enclosed universal joint is fitted to the propeller shaft, which enables the rudder and propeller to be raised or lowered at will by screw gear controlled from the cockpit or within easy reach of the helmsman's position. Other exhibits include a 25ft. cruising launch, an 18ft. yacht's motor launch, and a 12ft. "Consuta" hollow stern dinghy, with a twin-cylinder Saunders inboard portable engine. Several models of these small motors, with and without speed-reducing gear, are shown, and it is of interest to note that the new twin-cylinder model has ball bearings in the crank case, with an oil and gas-tight gland. Several examples of "Consuta" plywood construction are exhibited, one of which consists of a 9ft. rowing dinghy, which, complete with seats and oars, weighs under 100 lb.

Another type of light portable boat is the series of Ford folding boats, shown by J. B. Brooks and Co., Ld., of Birmingham. They are designed for accommodating from one to three persons, and weigh from 27 lb. to 45 lb.

Other medium-sized motor boats and river launches are displayed by E. Andrews and Sons, Maidenhead; Aldous, Ld., of Brightlingsea; George Spicer, of Brentford; and H. Gibbs, of Twickenham. Among the smaller engines, we noted examples of the Evinrude outboard motors, by the Evinrude Motor Company, of Waterloo-road, London; and the Johnson outboard motor, shown by Vanadium, Ld., of 64, Victoria-street, S.W. 1; while Bordewich (Engineering), Ld., of Hull, showed the Fortis marine motor, and also an example of the Ellwe crude oil engine. A group of interesting engines is that shown on the stand of the Bergius Company, Ld., of 254, Dobbie's-loan, Glasgow, where models of the Kelvin-sleeve type of engine may be seen. A 15 horse-power four-cylinder unit is sectioned, so that the various parts of the sleeve and valve mechanism can be examined. Engines varying in power from 7½ to 30 brake horse-power are displayed, along with a series of propeller shafts, stern tubes and propellers. Among the firms who are exhibiting boat fittings and appliances are Henry Hughes and Son, Ld., of 59, Fenchurch-street; A. T. Chamberlain and Co., of 107, Waterloo-road; Edison Accumulators, Ld., of Upper George-street, W. 1; and George Wilson and Co. (London), Ld., of 7, Sherwood-street, W. 1; while the Langdon Engineering Company (1924), Ld., of Southampton, is showing bilge pumps, silencers and the firm's patented reversing gear, one example of which is designed for an output of 120 brake horse-power at a speed of 1400 revolutions per minute. The Royal National Lifeboat Institution, of 22, Charing Cross-road, W.C. 2, is exhibiting one of the Institution's 35ft. pulling and sailing boats and a motor tractor such as is used for launching lifeboats on flat or sandy beaches. During the Exhibition various lectures will be given on yachting subjects, which will be delivered by special lecturers at five o'clock most afternoons, of which the following may be mentioned:—March 24th, Captain D. Nicholson, "The Standardisation of Boats"; 25th, Sir Wm. Burton, K.B.E., "My Yacht-racing Reminiscences"; 26th, Major B. Heckstall-Smith, "The Cutter Britannia"; 27th, Mr. E. G. Martin, "Cruising"; 28th, Mr. W. J. Daniels, "Model Yachts"; 31st, Mr. Morgan Giles, "The Technical Side of Dinghies"; April 1st, Sir H. Warwick Smith, "Dinghies and Dinghy Sailing." Considerable care, it is evident, has been expended in forming this Exhibition, and there is little doubt that it will prove to be quite as popular as in previous years.

A THAMES MOTOR TUG.

On Tuesday, the 17th inst., successful demonstration trials took place of the Thames motor tug Sparteolus, which will be used by her owners, A. H. Green and Co., Ld., of 77, Lower Thames-street, to do the river towing work of Bowaters' Paper Mills. The hull of the vessel was designed by Perman and Co., Ld., of 82–83, Fenchurch-street, E.C., which firm also supplied the Kromhout motor with which the ship is propelled. Messrs. Edward Hayes, of Stoney Stratford, built the hull, which was towed by canal to Brentford, where the engines were put aboard. The Sparteolus is a single-deck tug, with a straight stem and counter stern and high bulwarks. The wheel house is forward of the main engine casing, and is fitted with a portable roof. Behind the wheel house is the 2ft. 3in. diameter funnel, which is of the usual lowering type. Crew accommodation is provided forward. The main engine casing is particularly roomy and well ventilated, and provides for easy access both to the engine and its auxiliaries. Some particulars of the tug and its propelling motor are given in the following particulars:—Length overall, 54ft.; breadth, moulded, 12ft. 4in.; depth, moulded, 6ft. 6in.; draught, aft, 5ft. 6in.; diameter of propeller, 48in.; type of motor, two-cylinder Kromhout; diameter of cylinder, $13^{3}/_{16}$in.; stroke, $13^{13}/_{16}$in.; normal speed, 320 revolutions per minute; designed output, 100 brake horse-power; fuel oil consumed per brake horse-power hour, 0.51 lb.; guaranteed lubricating oil consumption not to exceed per brake horse-power hour, 0.01 lb. Although designed for a speed of 8 knots, 8.35 knots was easily attained on the measured mile run.

The engine is of the latest Kromhout marine pattern, with the patent roller type gudgeon pin, which does not require any lubrication. This and other features give a low lubricating oil consumption. A standard combined clutch and reverse gear is fitted, with a single control lever conveniently arranged aft, which operates the reversing gear, clutch, governor, and air throttle. An auxiliary lever is provided which enables the attendant to vary the speed of the engine within certain limits at any load. The engine is arranged for air starting at about 60 lb. per square inch pressure, and air storage vessels and a charging valve on the engine cylinder are fitted. A small Reavell hand-driven compressor is also installed for emergency use. The circulating pumps and bilge pumps are of the plunger type, driven direct from the crankshaft. A new feature on the engine is the rapid heater, which can be lit by a taper as soon as the air pressure is turned on. The cylinder heads are of the newest design, and are entirely water cooled, with the exception of small ignition pockets. The engine is capable of being started from cold by air at about 60 lb. per square inch pressure, after the heaters have been in operation six minutes. Large and effective silencers are fitted, and three fuel tanks are provided, containing about 560 gallons of oil fuel, sufficient to enable the engine to run at full speed for over 90 hours.

Books of Reference.

The Empire Commercial Guide and Year Book. Edited by Wm. C. Hart-Saxby. First edition. London: The British Commonwealth Trade Press, Ld., 212, High Holborn, W.C. 1. Price £1 1s.—This latest addition to the list of books of reference claims to be "A Complete and Authoritative Handbook to the Trade, Industry and Commerce of the British Empire." It is divided into six parts—Africa, Australia, New Zealand, and Oceania; Canada; Newfoundland and Labrador; the West Indies; India and the Far East—and an Appendix, and it contains a vast amount of information concerning the various countries of which it treats. So diversified, in fact, is the information that it is quite impossible to refer to it in detail, but it may be said that for most of the countries it includes particulars of such things as constitution; finance; weights and measures; commerce; industries, ports, telegraphs and telephones; shipping; banking; patents, designs, trademarks and copyright; internal communications; agriculture; pastoral production; mining; land settlement and tenure; forests and forestry; fruit growing, &c. &c. Data concerning the chief towns and their officials are also given. Altogether, we think that it is likely to be found to be a most useful work of reference, for it appears to give in one volume information which is only obtainable with difficulty elsewhere.

The River Tyne: Its Trade and Facilities.—This is an Official Handbook issued under the auspices of the Tyne Improvement Commission, the London and North-Eastern Railway Company, and the Corporations of Newcastle-upon-Tyne, Gateshead, Jarrow, South Shields, and Tyne. It is edited by Mr. R. W. Johnson, author of "The Making of the Tyne," and Mr. Richard Aughton, General Manager of the Tyne Improvement Commission, and is published by Andrew Reid and Co., Ld., Akenside Hill, Newcastle-upon-Tyne. The book, which is well got up and printed, contains a mass of useful and interesting information concerning this "man-made river," which in human memory was "little better than a ditch," but which now is a deep and busy harbour and waterway. It tells of the wet and dry docks of the Tyne, its coal trade and oil bunkering facilities, its shipbuilding and ship-repairing industries, and its trade; of the vessels using it; of its steamship services; of its bridges and tides; of its train services and siding connections; and of its public quays. Then come data concerning Newcastle, Gateshead, Jarrow, South Shields and Tynemouth, with particulars of sites suitable for works, and, finally, there are lists of railway, corporation and public officials, and of foreign consuls and vice-consuls in Newcastle. The volume is profusely and well illustrated with half-tone engravings, and there are plans of (*a*) the Albert Edward and Northumberland docks and coal shipping staiths; (*b*) Tyne Dock; and (*c*) the river between Newburn and the North Sea.

Chemical Engineering and Chemical Catalogue. Published by W. Leonard Hill, 173, Fleet-street, London, E.C. 4. Price £1 1s.—The title of this book of reference—which appears for the first time in the present issue—is somewhat misleading. To call it a "Directory" or a "Directory and Catalogue," rather than, simply, a "Catalogue," would, we think, give a better idea of its contents. It is a good deal more than just a catalogue. What it does is to tell those who consult it, who are the makers or preparers in this country of all sorts and kinds of chemicals and elements—metallic and non-metallic—as well as of materials and apparatus used in the chemical laboratory and in chemical engineering, and where they can be obtained. It should have a wide field of utility.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

MATHEMATICS AND ENGINEERS.

Sir,—May I, through the medium of your journal, voice an appeal for the simplification of specialist papers on technical matters involving the use of advanced mathematical processes?

The distinction between mathematician and engineer is self-evident, yet the researchers, whose original papers form the basis of all progress in theory of design, invariably present the mathematical argument in a manner comprehensible only to the mathematician, for reasons of brevity. To attempt to follow such papers in detail entails a vast amount of labour in reference to advanced mathematical works, frequently attended by slight success.

I venture to suggest that it would be of incalculable benefit to the engineering profession in general if authors were to publish keys to their original papers, in which the implied mathematical processes might be worked out in detail, with fuller explanation of principles, this work being undertaken by assistants. There is, of course, ample scope for the simplification of the mass of specialist publications already in existence.

The advantages of easy access to the latest advances in theory and their direct application to engineering problems must surely be admitted; while any medium which is instrumental in re-vitalising the mathematical technique of the engineer, in the most direct manner, seems worthy of encouragement. Mathematics being the life blood of engineering, the two cannot reasonably be confined within separate water-tight compartments. The time-worn "factor of safety" is slowly but surely giving place to higher orders of stress computation, and what yesterday was the technique of the mathematician is to-day becoming that of the engineer.

March 16th. H. C. K.

A Million-volt Arc.—At the works of Ferranti Ld., of Hollinwood, a pressure of one million volts was recently obtained by means of three transformers connected in cascade in accordance with the Dessauer patent, for which Ferranti and Co., Ld., are the sole licencees for the greater part of the British Empire. The primary of the first transformer was connected to a 6600, 60-period supply and gave 333,000 volts at its secondary terminals. The second transformer was insulated from earth and one end of its primary winding was connected to the 333,000-volt terminal of the first transformer and the other end to a 321,000-volt tapping. In this way the secondary winding of the second transformer raised the pressure to 666,000 volts above earth. Similarly the third transformer was insulated from earth and was supplied from the second transformer, and the pressure was thus raised to one million volts above earth, all these voltages being R.M.S. values, the actual peak value across the 9ft. 6in. arc being 1,400,000 volts. A sustained arc was obtained and the value of the pressure was calculated from the voltage ratios of the transformers and was checked by the length of the spark gap, which was adjusted according to the humidity of the atmosphere. The earth connection was made by means of a limiting resistance.

Railway Matters.

THE Southern Railway has made proposals to the Portsmouth Town Council which would lead to the replacement of the Town and Fratton Stations by a new one at Somers-road Bridge, midway between the two present stations.

IT is officially announced that Lieutenant-Colonel F. A. Cortez Leigh, hitherto electrical engineer to the Western Division of the London, Midland and Scottish Railway, has been appointed electrical engineer for the whole of the system and will be in charge of a separate department, which will be responsible for all electrification schemes.

THE new railway in Algeria from Tlemcen to the port of Beni-Saf has begun operation. It will permit the greater use of this port, particularly for the transhipment of iron ores from the Camerata-Tafna district. Surveys of the region are said to have disclosed extensive iron ore deposits, the region being especially rich in red hematite with a high percentage of iron content. Practically all the hematite produced in this district is shipped to this country from the port of Beni-Saf. It is expected that the new railway, by reducing the cost of transport, will stimulate iron ore production in the district.

THE London Underground railways have issued a statement to the effect that to facilitate the increased services it has become necessary to make various additions and rearrangements to the equipments of certain sub-stations that are at present susceptible to overload. At Victoria a new 2000-kilowatt rotary converter will replace one of the existing 1200-kilowatt machines, which will be transferred to Russell-square. A new 1500-kilowatt rotary converter is to be installed at Baker-street, and that will necessitate enlarging the sub-station building. A 900-kilowatt machine is also to be transferred from the Woodlane sub-station to Bond-street. At the Lots-road power station ten high-tension group switches, controlling the supply of current to the sub-stations are to be replaced by modern switches of improved design. To augment the supply of air for signalling purposes 12 new air compressors are to be put into service on different parts of the system.

THE National Union of Railwaymen has included the railway shopmen among those for whom it has submitted to the companies an "all-grades programme." The companies object to their inclusion since their grade and some others are not covered by the conciliation scheme, and are, therefore, not subject to the Central and National Wages Boards. Mr. Cramp, the industrial secretary of the National Union of Railwaymen, has announced that after an insistent demand the companies have offered to set up machinery to negotiate on the shopmen's claim if the National Union of Railwaymen will meet all the other craft unions and mutually agree upon the machinery to be instituted. The National Union of Railwaymen has decided to do this, and hopes that the other unions will sink all their differences of organisation and come together in the interests of the great body of men. The National Union of Railwaymen will not under any circumstances abandon its programme.

ACCORDING to the Board of Trade returns the value of the railway material exported in January last was as follows, the figures for the same month of 1924 and 1923 being added in brackets:—Locomotives, £372,793 (£209,483, £253,344); rails, £238,930 (£185,616, £130,243); carriages, £158,920 (£132,561, £202,346); wagons, £368,121 (£374,210, £191,077); tires and axles, £42,297 (£57,770, £32,777); wheels and axles, £58,555 (£45,630, £70,238); chairs and metal sleepers, £26,425 (£141,139, £30,840); miscellaneous permanent way, £124,003 (£116,100, £111,091); total permanent way, £491,823 (£559,951, £407,634). The weight of the rails exported was 24,566 tons (21,841 tons, 16,583 tons), and of the chairs and metal sleepers, 1939 tons (11,738 tons, 2704 tons). In January, 1924, locomotives of the following values were shipped to the countries named:—India, £197,340; South Africa, 76,964; Australia, 37,780; and rails as follows:—The Argentine, £89,009; New Zealand, £76,684; Australia, £17,411; India, £12,578.

IN the Indian Railway Budget for 1925–26 an additional capital expenditure of 23 crores of rupees is proposed, over 6½ crores of which is for construction of new lines. The programme provides for the ultimate addition of over two thousand miles of line, of which 348 miles will be opened in 1925–26. Of the new projects that for connecting Raipur with Vizagapatam by a railway 260 miles in length to Parvatipur is the most important, and it is hoped to undertake it at an estimated cost of 536 lakhs of rupees, simultaneously with the development of the Vizagapatam Harbour. Considerable progress is anticipated with the Central Indian coalfields railway and with other lines in the Bengal-Nagpur Railway area which will serve the coalfields. Allotments are made for a large number of new projects in Burma and Southern India, and a small amount is provided for preliminary expenditure on relieving the congested state of the downward coal traffic into Calcutta by providing better railway communications between the coalfields and the docks.

HAVING regard to the remark as to square men in round holes made by Sir Guy Granet, the chairman of the London, Midland and Scottish, which we quoted in a leading article on December 26th last, it is interesting to note that that gentleman, at the company's annual meeting on February 27th, said: "We have had our internal troubles. One of these was that the rolling stock had not been as efficient as before the war; all had rather underestimated the bad effects of the war on the property. They had not been able to repair it in accordance with the usual standard, and could not work the traffic anything like so efficiently with stock so much more liable to break down." Sir Guy continued:—"Our other internal trouble has been the difficulty, inherent to so large an amalgamation, of setting our machine on right lines and getting it to work sweetly. Here, again, though we cannot be as certain in our diagnosis as in the case of rolling stock, we think we are advancing on right lines, and that 1925 will be marked by a feeling of greater certainty and contentment on the part of the staff, which will be reflected, we believe, in improved operating results."

Notes and Memoranda.

WHAT is claimed to be a world's record in hoisting coal from a single shaft was recently made at Valier, Illinois, when 8664 tons—presumably short tons—were hoisted from a depth of 672ft. in 7 hours 51 minutes. The winder is driven by a 1350 horse-power electric motor.

IN the course of a paper on "The Limiting Possibilities in Steam Plants," read by Professor A. L. Mellanby, D.Sc., and Professor William Kerr, Ph.D., before a meeting of the North-East Coast Institution of Engineers and Shipbuilders, at Newcastle-on-Tyne, recently, the authors remarked that in their opinion the temperature limit was about 900 deg. Fah., while for pressure 1250 lb. per square inch might be considered as the upper limit.

A COMBINATION oil and safety lamp for miners has been produced and is claimed to give a working light for 22 hours. Either illuminant is automatically extinguished when the other takes its place. Another lamp is designed to emit a musical note when 2 per cent. of harmful gases are present in the atmosphere. Canary-tinted glass has been used with miners' lamps and the colour is said to be beneficial in checking nystagmus. It is considered that the illumination furnished by miners' lamps is too low, and the possibility of securing higher illumination by means of fixed lamps is discussed.

WRITING in the *Engineering News-Record* Mr. F. M. Holmquist points out that loss from the washing away of railway trestles in flood time might be materially reduced and the damage more quickly repaired if such trestles were so designed that if one section fails it will easily separate from the rest. He once saw 1000ft. of trestle go out when only 200ft. would have gone had it not been that the rails and stringers holding together pulled the rest of the structure with it. Such a design, he says, should present no great difficulties. At intervals of 100ft. all stringers could be cut at the bents, thus leaving only the rails to hold the deck together. The rails might also be laid with joints at these bents with possibly a special design of joint which would fail with a strong side pull without diminished capacity to support vertical loads.

ACCORDING to a New Zealand correspondent of the *Chemical Trade Journal*, at least two satisfactory commercial processes have now been devised for producing a high quality, dirt-free, dry gum from Kauri gum swamp "chips." These processes have been tested thoroughly, and two companies, largely capitalised and controlled by British varnish interests, are to subject them to comprehensive exploitation. One of the companies in question, the Parenga Kauri Oil Company, has been offered a contract, extending to seven years, for 2000 tons a year. The most recent development in the situation is the request recently made to the New Zealand Government by an English company for a concession of over 60,000 acres of gum lands. The company proposes to utilise the pulp wood of the timber swamps for paper making.

THE pessimist would have us believe that the petroleum supply of the world will be exhausted in something like another twenty years. Consideration of the known fields might lead to this conclusion, but, says the *Motor-Cycle*, it is now fairly safe to say that the oil, even of these fields, is not so transient as these folk think. It is popularly supposed that certain fields have now been depleted, but the fact is that they have only been exploited with shallow wells, and in many cases no measures have been taken to prevent destructive water seepage from water-sand strata—one of the biggest problems of intensive oil mining. The result is that, for want of scientific control, these fields have stopped producing. Now it is as expensive to get ruined oilfields back into production as it is to get depleted land back into profitable cultivation, as has been found in many of the wheat areas of Canada. On the other hand, more conscientious working will produce much more oil in the future.

AT a meeting of the North of England Branch of the Association of Mining Electrical Engineers, held on March 4th at Newcastle-on-Tyne, Mr. A. Bannister read a paper entitled "Pole-mounted Outdoor Sub-stations." Comparing the cost of indoor and outdoor equipment, the author said that it would be found that the overall saving that could be effected on a sub-station would depend largely on the type of apparatus used, the voltage of the system, and, to some extent, the capacity of the sub-station. As far as the transformers were concerned, the cost of a transformer for outdoor service was rather higher than that of the corresponding indoor unit, and, therefore, the reduction in cost required must take place in the cost of the switchgear. This cost could be greatly reduced by using air-break apparatus in place of oil-circuit breakers, and, at the same time, the space question was solved, as if necessity the air-break apparatus, being entirely open, must be mounted out of the way. This type of gear lent itself very readily to pole-mounting, and, as in the smaller sizes the transformer could also be pole-mounted, a very compact arrangement of sub-station resulted, and one which required a minimum of space, *i.e.*, just sufficient to mount the pole.

MORE than 30,000 miners in the United States received certificates from the Department of the Interior for proficiency in the use of self-contained mine rescue oxygen breathing apparatus after a complete course of training from instructors of the Bureau of Mines. Possibly 5000 other miners have been trained by State mining departments and mine operators. Several thousand self-contained mine rescue oxygen breathing apparatus have been sold in the United States; the Bureau of Mines alone owns about 300 sets. Employees of the bureau have used breathing apparatus as a means of saving life or property at 151 mine explosions or mine fires. In some States, notably Utah and Washington, mining codes require rescue apparatus to be part of the equipment at mines of certain size and character. Illinois, Ohio, Kansas, and West Virginia have established State mine rescue stations. In a number of States the insurance rates, under compensation-insurance laws, for certain classes of mines are considerably lowered by the installation of mine rescue apparatus and mine rescue stations. Many large, progressive mining companies now maintain a regularly trained rescue corps of five or more men each, equipped with the necessary apparatus.

Miscellanea.

THE policy of Canton in widening its streets has been adopted by Wuchow, the next large city up the West River, and the city walls are being pulled down to make room for a boulevard, while the main street has been widened from 10ft. up to 40ft.

IT is understood that the agreement with the Indian Radio Telegraph Company has been signed to proceed with the erection of a wireless station for the inauguration of a commercial service with the United Kingdom in connection with the beam wireless system.

ALBERTA'S coal production last year was 5,203,713 tons, the output ranking sixth in point of quantity since the industry was established. The peak was reached in 1920, when the production was 6,907,000 tons. The miners' five months' strike last year reduced the output.

THE plumbago trade of Ceylon is seriously threatened by Madagascar competition, as the latter island is able to underquote the Ceylon producers in the markets of Europe and America. Recent inquiries in England, the Continent and America elicited the fact that Madagascar graphite is considered suitable for purposes for which Ceylon plumbago was at one time considered indispensable.

THE utility of an electric truck is materially increased by the convenient position of charging facilities. There are now thirty-five stations in Chicago where plants giving from 40 ampères to 250 ampères are available for battery charging. The electric truck bureau of the Commonwealth Edison Company has published and distributed to users and prospective users of electric trucks a map of the city with all charging stations indicated, giving details of charging facilities available.

THE Ontario Hydro-Electric Power Commission has been authorised by the Provincial Government to develop power at Rocher Fondu on the Ottawa River near Arnprior. The development, with storage, will provide from 45,000 to 66,000 horse-power for Eastern Ontario. The cost is estimated at over 5,000,000 dollars. It is proposed to erect the plant on an island on the Quebec side of the river, which will involve negotiations with the Quebec Government. The Commission has made application for several other sites on the Ottawa River.

THE Institution of Electrical Engineers has issued particulars of the next International Conference on large extra high-tension electric supply systems, to be held in Paris from June 16th to 25th. The Council of the Institution has set up a British National Committee representative of the sections of the industry that would be interested in the conference. Any member of the Institution may become a free member of the conference by sending in his name to the secretary, together with a remittance of £1 2s. 6d. in respect of subscription for membership. Particulars of this conference were given in our issue of the 6th inst.

UP till now, states the *Wireless World*, Austria has had to be content with only a 1-kilowatt broadcast station in Vienna, although even this is still the largest in that country, but of late enthusiasm of listeners has grown to such an extent that the Austrian Broadcasting Company, which has the monopoly for broadcasting, has responded to the demand, and announces that plans are being made for the erection of a station of considerably higher power. The studio of the old station is situated on the top floor of the old Austro-Hungarian War Office, but unfortunately the accommodation is not sufficient for a large orchestra to be arranged at the proper distance from the microphone, and so listeners have had to be content with less elaborate programmes.

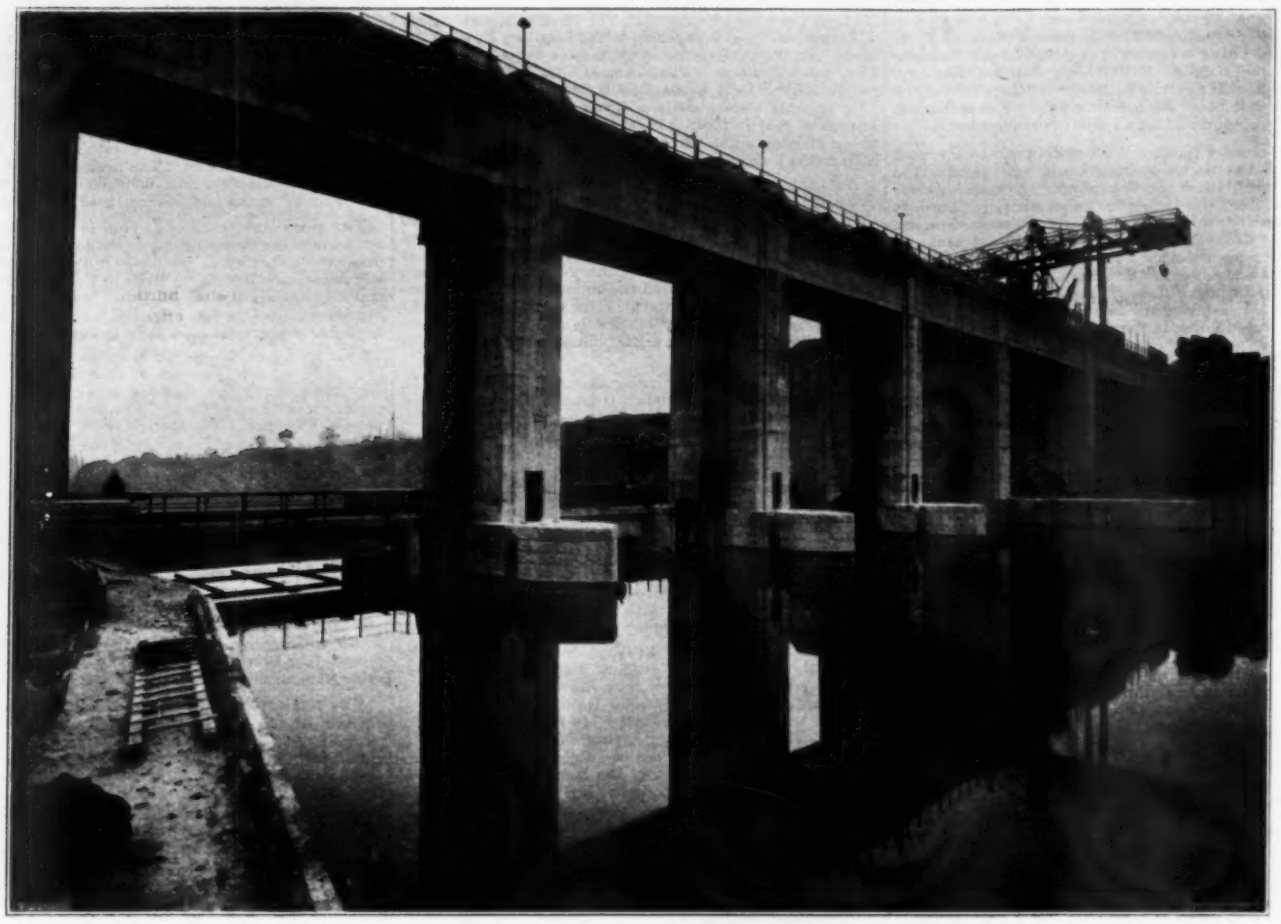
ONE of the most daring feats of Italian industry during the Great War was that accomplished by the Ansaldo Company, which in 1916 acquired, in view of army requirements, the iron mines in the Valle di Cogne, near Aosta, at an altitude of some 8000ft. above the sea level, situated amid lofty mountain peaks far from all railway or other facilities. To-day these mines, with an ascertained content in the section now worked of 12 million tons of ore of exceptionally fine quality, are owned by the Ansaldo-Cogne Company, formed with the participation of the Italian Government, which holds shares for an amount of 75 million lire. These mines and the annexed electric steel plants were recently visited by a large group of business men and engineers interested in the metal industries, who had an opportunity of examining the splendid and unusual plant.

A RECORD in the loading of cargo was achieved at the Cape Town docks on February 18th, when the ss. Glenmoor, of the Moor Line, was loaded with 4230 tons of grain in bulk in 4 hours 10 minutes working time. It was really the first full test that the new grain elevator at the docks, which has a capacity of 32,000 tons, has been put to, as it was only completed in time for this season's maize crop, which has been so small, owing to the drought and ravages of the locusts in last year, that the quantity available for shipment has been but trifling. In loading the vessel four chutes were used, the average for each being 255 tons per hour, or 1020 tons per hour into the hold. In the ordinary course of handling maize for shipment in former seasons, the total loaded per hour has been about 25 tons per crane, which would have meant that to load the Glenmoor would have taken 5½ days.

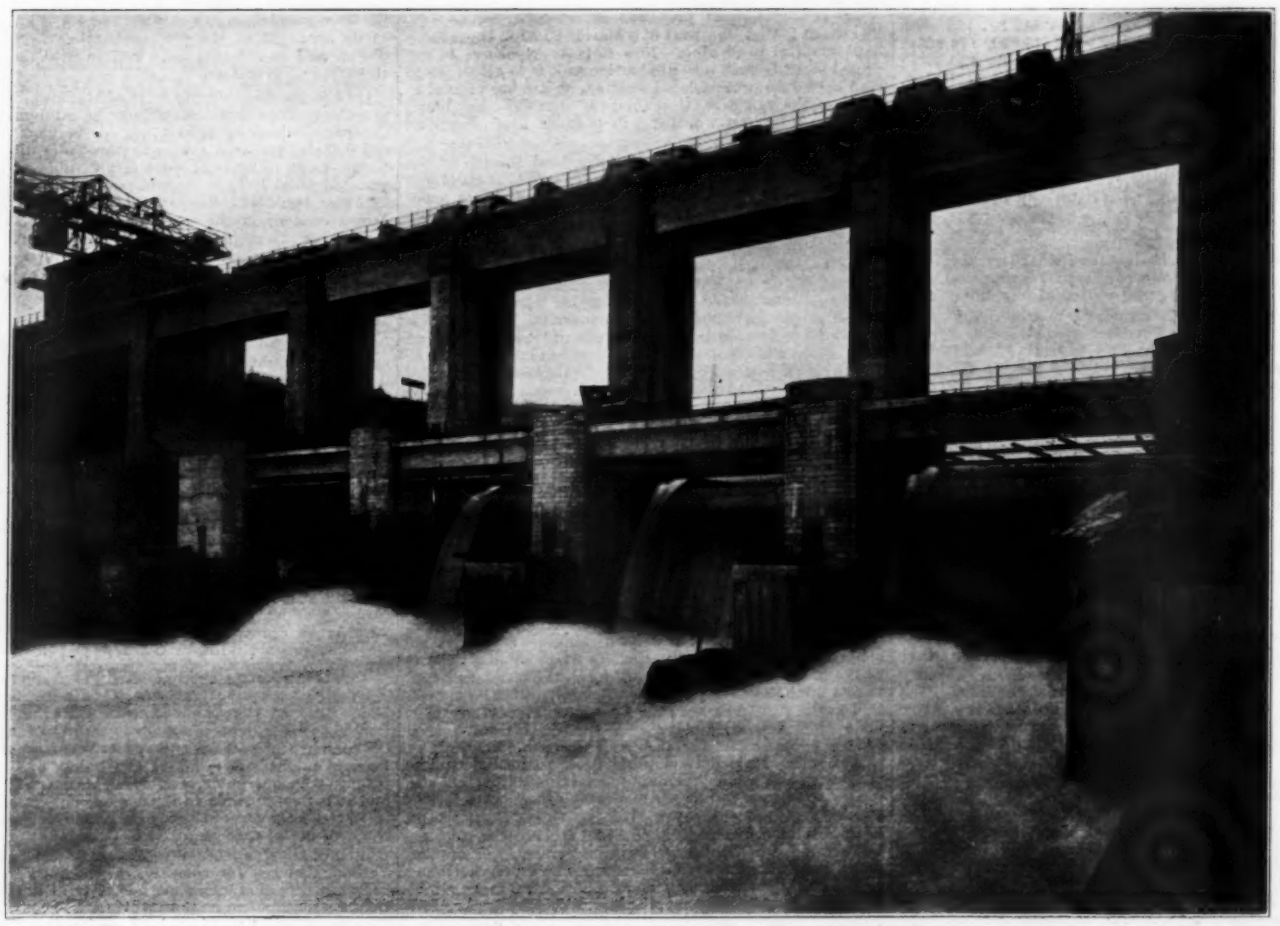
THE Hong Kong Government, states *Indian and Eastern Engineering*, is taking up the question of amateur radio work. It is explained that the reason the Government has been unable to issue licences earlier is that the unsettled state of China has made it difficult to institute a scheme whereby licences might not fall into the hands of objectionable people. Since then the staff available has been increased, and it is now possible to issue the licences with a stricter supervision than would have been possible before. Pending the drafting of the necessary licences, the Government is willing to allow amateurs to proceed when the local Radio Society vouches for them. For the purpose of broadcasting, the Government intends to erect in the very near future a radiophone station, which will be used principally for the distribution of typhoon and police warnings and other matters of public interest in plain language. Later, programmes of music, &c., will be arranged.

THE CHANCY-POUGNY HYDRO-ELECTRIC POWER STATION

(*For description see page 321*)



UPSTREAM VIEW OF BARRAGE ACROSS THE RHONE



DOWNSTREAM VIEW OF BARRAGE SHOWING SLUICES DISCHARGING

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DEATH.

MONDAY, 9th, at "Oaklands," Sherbrooke-avenue, Pollokshields, Glasgow, ROBERT HARVEY, Chairman and managing director of the Harvey Engineering Co., Ld., of Glasgow.

THE ENGINEER.

MARCH 20, 1925.

The Navy Estimates.

THE Navy Estimates for 1925–26 show a net total of £60,500,000, which is £4,700,000 more than those for the expiring financial year. We learn from the First Lord's memorandum, however, that considerably more than half of the net increase is due, first, to charges in connection with the Fleet Air Arm, which have not hitherto appeared in Navy votes; and secondly, to increases in wages and prices, the automatic growth of non-effective Votes, and the depletion of surplus war stores. In accordance with the Government's decision, a special overhead deduction has been made on the provision of contract work in the votes for shipbuilding, naval armaments and works to discount in advance possible delays in the progress of such work. If, however, no delays occur, Parliament will in due course be invited to make good the deficiency to whatever extent may be necessary. In spite of their somewhat formidable total, the Estimates for the coming year do not provide for any new construction. This omission is the more surprising in view of the strong protest that was raised by members of the present Government when the Labour Cabinet whittled down the building programme which had been introduced by Mr. Baldwin's first administration. The programme in question was put forward as being, in the Admiralty's judgment, the minimum required to maintain the accepted standard of naval strength. Eight cruisers and twelve other vessels were demanded. One of the first acts of the Labour Government was to strike out three cruisers and all but two of the subsidiary craft. When the political pendulum swung back and Mr. Baldwin returned to office with an overwhelming majority it was widely assumed that the vessels so dropped would be reinstated in the next Navy Estimates, together with such additional ships as might be needed to maintain the Admiralty's policy of replacing obsolete material. This has not been done. On the contrary, an investigation into the whole question of ship replacement is now in progress, though it is difficult to see why such an inquiry is necessary. As long ago as October, 1923, the country was given to understand that new ships were urgently required as substitutes for those that were becoming ineffective. The replacement of cruisers called for particular attention, and we were assured that fifty-two of those vessels would have to be laid down in the next ten years. Reasons were given, moreover, why the building of new cruisers should be pushed on as rapidly as possible—that is to say, at more than the average rate of five each year, the principal reason being that, from 1927 onward, the shipyards would have to deal with heavy destroyer contracts.

Such was the policy foreshadowed by Mr. Baldwin in his speech at Plymouth on October 25th, 1923. So far as we know, nothing has occurred in the interim to modify naval shipbuilding requirements. Foreign programmes in hand at that date have, indeed, been expanded, with the result that our relative strength has suffered a further decline. There are, no doubt, good reasons for the Government's decision to suspend further naval construction for the time being. It is clear to all that the country cannot prosper until something is done to relieve the intolerable burden of taxation, and if relief is only to be effected by cutting down expenditure on armaments, the risks which such a policy entails must perforce be accepted. But to carry the process too far would be not only dangerous but uneconomical. The expedient has been tried before, and always with the same result. Sooner or later the country, finding its defences falling into neglect, exhibits symptoms of alarm and loudly demands remedial measures which may go beyond the immediate necessities of the situation. Then follows a sudden and heavy increase in expenditure, which generally wipes out the savings of preceding years and, incidentally, has an undesirable reaction on our relations with foreign Powers. Alternating periods of irrational retrenchment and "panic" expenditure may be said to constitute the history of our defence policy for several generations past. It is therefore earnestly to be hoped that no opportunist considerations will be permitted to override the reasonable claims of the Navy. From the wording of the First Lord's memorandum it would appear that a shipbuilding programme is to be presented later in the year, when the inquiry now proceeding has been completed. Having regard to the preponderance of obsolescent ships in the fleet of to-day, there can be no question as to the urgent need of new material. Neither in age nor general efficiency do our existing cruisers compare well with those of certain other Powers. Since the war we have laid down only five ships of this type, while the United States have built ten and Japan twenty. The disparity is still more pronounced in respect of destroyers and submarines. Invidious or not, such comparisons cannot be banished from any practical discussion on our naval requirements. The surest method of avoiding them is to make timely and adequate provision for our own needs. The explanatory notes which accompany the Estimates show that among the vessels for the completion of which funds are asked are three cruisers and two submarines. These five vessels were begun during the war, and the slow rate of construction has added substantially to their cost. Work is to proceed during the year on the battleships Nelson and Rodney, which were laid down in December, 1922, and are not yet afloat; the five cruisers of the "Kent" class, the minelayer Adventure, the destroyers Amazon and Ambuscade, and submarine O. 1. A further charge is to be incurred in connection with the large submarine X. 1, the trials of which have not yet been completed. When finally available for service this remarkable vessel will have cost more than £900,000. Three cruisers of large tonnage are being converted into aircraft carriers. Of these the Furious is all but completed, and good progress is being made with the Courageous and Glorious, which are of the same general type. As cruisers these three ships were of doubtful value; as aircraft tenders they should prove invaluable, thanks to their ample deck space and high speed of 31 knots. We are not surprised to hear that boiler repairs on a large scale will occupy the Royal Dockyards during the next few years. The greater part of our fleet now consists of vessels which saw hard service in the war. The fact that many of them are still good steamers is a fine tribute to the quality of the workmanship put into their machinery. But there is a limit to the endurance of the best material, and it has now become necessary to renew the boiler tubes of practically all cruisers and destroyers which date from the war.

If the Navy has not yet emancipated its aviation service from the leading strings of the Air Ministry, it appears to have made a fresh stride in that direction. No other inference can be drawn from the inclusion in the new Estimates of a large sum "on account of the cost of the Fleet Air Arm," for it is scarcely conceivable that the Admiralty would

countenance heavy expenditure on a branch of its service—and an integral branch at that—over which it was to be denied absolute control. Eighty naval officers are now undergoing instruction at Netheravon as air pilots, and when fully trained they will relieve an equivalent number of Royal Air Force officers who are at present serving in the Fleet Air Arm. As this principle is to be extended, it is only a question of time before naval men entirely replace members of the R.A.F. as pilots and observers in the Navy's air service, thus bringing the present anomalous system to an end. The possible utility of airships for naval scouting in great oceans is recognised by the Admiralty, which in concert with the Air Ministry is studying the designs of mooring masts in ships. Such masts have already been tried experimentally in the United States Navy, apparently with good results. Other technical matters referred to are the recent gunnery tests with H.M.S. Monarch, which enabled the younger officers and men to take part in live shell practice against a ship target and the provision of a stronger anti-aircraft armament, with up-to-date control instruments, in H.M. ships. The official return of fleets, published earlier in the month, discloses the fact that nearly all vessels on the active list have lately been equipped with numerous 3-pounder or 2-pounder Q.F. guns, each of the capital ships mounting nineteen of these weapons, the cruisers twelve to eighteen, and the destroyers six. Such guns ought to prove very effective against aircraft at any height from which bombs or torpedoes could be released with accuracy. Another item of interest relates to the course of training at the Royal Naval Engineering College, Keyham, which has been reorganised in accordance with the most modern ideas. It is hoped in the coming year further to develop the system of vocational training of naval ratings with the view to improving their qualifications for employment after leaving the service. This training will in future be imparted to men on foreign stations, as well as at home ports and in sea-going ships. The Navy has now parted with all the capital ships it was required to discard under the Washington Treaty. Two were sunk at sea, and the remaining eighteen, with a total of some 400,000 tons displacement, have been broken up by firms in this country. Finally, since the naval clauses of the Peace Treaty have been completely carried out, the Naval Inter-Allied Commission of Control in Germany has been withdrawn.

Helium and Caisson Disease.

It is well known that what is termed Caisson Disease or Caisson Sickness is caused by the formation—as the result of too rapid decompression—of bubbles of nitrogen in the human body. The inert constituent of atmospheric air, is, when the diver or other worker is under heavy pressure, absorbed in abnormal amounts by the tissues and fluids of the body. Should the pressure be reduced too suddenly, the gases constituting the air are set free from solution, and the nitrogen tends to form bubbles very much in the same way as bubbles are produced when a bottle of carbonated liquid is opened. Apparently, the oxygen is not nearly so soluble as the nitrogen, and it is the latter gas which is responsible for practically all the trouble. The bubbles are most dangerous when they form in the spinal cord or in the brain, for then paralysis or even death may occur. The cause of the malady has been recognised for many years, and it was long ago discovered that, in order to avoid ill effects, especially when dealing with very high pressures, slow decompression was an absolute necessity. Unfortunately, with these very high pressures, the decompression time may become so lengthened as to be out of all proportion to the time during which a man can work profitably under those pressures. Although the rate at which the pressure may be applied, or the speed at which a diver may be lowered to the desired depth, may be relatively quick without the worker being distressed, decompression must be slow if disaster is to be avoided. Take the case of a depth of water of 200ft., which is looked upon as the limit—if indeed it be not beyond the limit—at which work can be carried on by an experienced diver. The man might be safely lowered to that depth in five to ten minutes, but at least two hours would have to be spent in his ascent, after a stay of only some forty-five minutes.

It is the solubility of nitrogen which limits the pressures under which it is possible for human beings to work. Up to comparatively recent times the difficulty was looked upon as unavoidable, but for some months past the United States Bureau of Mines has been directing experiments upon the replacement of air by mixtures of helium and oxygen. Three scientists of distinction are in charge of these experiments. They are :—Mr. R. R. Sayers, who is Chief Surgeon to the Bureau of Mines and a surgeon in the United States Public Health Service ; Mr. W. P. Yant, who is Associate Chemist at the Bureau's Pittsburgh Experiment Station ; and Mr. J. H. Hildebrand, who is Professor of Chemistry at the University of California and Consulting Chemist to the Bureau. The experiments have hitherto been made mainly on white rats and guinea pigs, and less extensively upon human beings, but it is intended to prosecute experiments upon men a good deal farther. A report—Serial No. 2670—recently issued by the Bureau gives a summary of the results obtained up to the present time. From it we learn that the substitution of helium for the nitrogen ordinarily present in air results in the production of an atmosphere which is as respirable as that provided by nature. It has been discovered, too, that helium gas not only has the advantage of being less soluble than nitrogen in the tissues and fluids of the human body, but also has the property of diffusing more rapidly in those tissues and fluids. Hence there is rapid elimination of the gas from the tissues during decompression, and, as a consequence, if we may accept the experiments on small animals as conclusive, the decompression time may be materially reduced when such a mixture is employed. According to the report, in the experiments made with rats and guinea pigs decompression could without detriment be made from the helium-oxygen mixtures in as short a time as one-sixth of that necessary with air or with nitrogen-oxygen mixtures—the exposure to pressure being of the same duration in comparable cases. From the few preliminary experiments made on men, it appears, too, that decompression can be made in from one-fourth to one-eighth the time ordinarily recommended for air. No particulars regarding these "men tests" are given, as they have not yet advanced beyond the initial stages ; but it is announced that the United States Navy Department is co-operating with the Bureau of Mines in carrying out an extensive programme with men. We have not the space here to describe in detail the nature of the experiments made on the animals, but it may be said of them that they were performed with great thoroughness and care, and that they have led to the acquisition of new knowledge.

There is no doubt that, if a means of very materially reducing the decompression time, without producing ill effects, has been found, a discovery of considerable scientific importance has been made. It is perhaps too early as yet to speak with any confidence, but it seems to follow that, if the decompression time can be reduced, the working time can be prolonged without causing undue fatigue. Moreover, it does not seem too much to anticipate that a further outcome of this easier decompression may render it possible in future for men to work under pressures still higher than those now attempted. In any case, a report on the further "man tests" will be looked forward to with interest ; for, however apparently convincing tests on animals may be, tests on animals—especially such small animals as rats and guinea pigs—are not the same as tests on human beings. Granting for the sake of argument that a method of very considerably reducing the decompression time has been evolved, the question at once arises, Would the substitution of a helium-oxygen mixture for common air be commercially possible ? On the subject of cost the report is silent. It is known, though, that helium is a rare gas. It does not exist in large quantity in any part of the world. At the moment, it is only produced in any volume in one country—the United States—where, we believe, its present price is about 15 to 20 times that of hydrogen. So far as is known, there is no source from which it could be obtained in this country at a cost in any way comparable even with that figure. Hence, were we to adopt it for home use, we should have to import the gas from America, if, indeed, that country had any to spare. The freight charges would then add to the cost of an already high-priced material. In any case, to supply the comparatively small quantity of the gas required to keep a diver at work for only a few hours a day would be an expensive business, and to employ it for such work as sinking caissons would seem to be out of the question. It is quite conceivable, however, that occasions might arise in which, no matter what the outlay, the money would be well spent, if only the object aimed at could be achieved.

The Case for the Owners of the Gleno Dam.

In an article in The Engineer, December 12th, 1924, presenting the findings of the Commission of two members appointed by the Italian authorities to inquire into the causes of the failure of the Gleno dam, it was pointed out that some delay in making a reference to the report was due to the probability that there would be some further information or fresh developments, which could have conveniently been considered in conjunction with the official report.

Since then a report has been made by a Committee appointed by the owners of the dam, the Galeazzo Vigano Company, and in view of the constitution of that Committee, its findings cannot be ignored, whilst in any event, it is only fair to present the case for the owners, belated though it be. The Committee consisted of Professor Mario Baroni, M. Ugo Grauzotto, M. Luigi Kambo, and M. Urbano Marzoli. M. Kambo was the engineer in charge of the building of the Tirso dam, in Sardinia, and was responsible for the modification of its original design, and his qualifications are therefore beyond question.

The report contradicts in almost every particular the findings of the officially appointed Commission, and the conclusion arrived at is that the dam was deliberately destroyed by a criminal and with a charge of dynamite. The following are, in brief, the main conclusions and opinions of the Committee appointed by the owners.

The lime was burned in a kiln near the site under the supervision of a competent engineer, and both it and the stone were tested properly and with satisfactory results. Cement from trustworthy sources was added to the lime, though the specifications called for the use of lime only. The plans, modified to allow of the building of a multiple arch dam, were passed by the competent authority and the dam, thus approved, was built according to those plans. The contract was entrusted to a firm having experience in building the multiple arch dam at Scoltenna. The work was assiduously supervised by competent persons. After the winter of 1922–1923 the reservoir was emptied and the dam carefully examined throughout, and found to be in sound condition. The work was finished by October 14th, 1923, having shown no sign of any weakness or lack of stability. A careful examination of the dam was made on October 23rd by a Government engineer officer.

The Committee also found that the rock was a suitable foundation, that 7400 cubic metres of rock were excavated, that there was no sliding of the dam on the rock, that the tests showed the lime to be of good quality, and that reinforcement, additional to that called for by the specifications, was suitably introduced. As regards leakage, said to have occurred when the dam began to fill, it is not admitted that it was serious, and a photograph shows it to have been but small. With respect to criticisms of the theoretical stability of the dam, made by foreign engineers, the Committee, having gone through the calculations, concludes that the design is that of a theoretically stable structure. The much criticised piers, No. 8 and No. 9, were sufficiently stable. The maximum pressure in the dam was 12.3 kilos. per square centimetre, under the most unfavourable conditions.

The Cause of the Collapse.

In seeking for the probable cause of the collapse of the dam, the Committee, rejecting other suppositions, believes that it was due to a violent shock in the outlet tunnel, and considers that evidence that it was so is afforded by the appearance of the ruins of the tunnel, including that of the fractures in the masonry. In this they are supported by Colonel O. Cujini, an engineer officer of the Italian Army, who examined the ruins of the tunnel and expressed the opinion that there were signs of the effects of a high explosive. The Committee concludes that the dam was deliberately destroyed by a criminal who placed a charge of dynamite under the roof of the tunnel and left it to explode.

* * * * * *

This report has to be considered in several aspects. In the first place, it emphasises the responsibility of the authorities as regards the design and specifications, a matter which does not concern the engineering profession in its attempt to grasp the main facts and the technical significance of the disaster. The Committee does not blame the authorities, because it is held that the design and specifications were satisfactory. As to the facts relating to the specifications and the way in which the work was carried out, a reference to the article in The Engineer of December 12th, will show that these matters were presented somewhat differently by the official Commission. As regards the actual building of the dam, no amount of evidence as to supervision and tests can be conclusive unless it be based on daily reports of the quantities and proportions used. Even then the accuracy of such records may be questioned, and one day of slackness in supervision may, in a case like this, be fatal to the security of the structure. Furthermore, there is the evidence afforded by the manner in which it was disrupted, and its composition, as disclosed by tests taken after the disaster.

There is also to be considered the attitude of the

Committee with respect to outside expert criticism. It is not, it seems, a simple case of expert against expert, for the independent calculations made by M. Stucky and others do not seem to be opposed by any such fresh and independent calculations by a member of the Defence Committee; probably a very significant point.

Coming, then, to the last days and moments of the dam's short period of service, two alternative pictures are presented. The report of the official Commission:—Leakage steadily increasing and noticed by an independent witness, who saw water "spouting" from the dam. On the last morning, the watchman, passing with his lantern, feeling a movement, hearing stones or pieces of masonry falling, seeing first one crack, then another which seemed to be widening, starting to run, and turning to see the dam crumbling. Then the rush of water.

The report of the owners' Committee:—All was well until the last moment; the leakage was not serious. The dam was destroyed by dynamite. Either the watchman lied, or the movement which he felt was due to the explosion of a charge no more than sufficient for its purpose. This is not in their report, but it is implied, and if the watchman's tale was true, there was no explosion, unless he was deaf. The whole affair, as far as direct evidence concerning the actual manner in which the dam collapsed is in question, comes to a sharp point at the watchman, and whether he was deaf or not is vital to the issue, in so far as the explosion theory may be admitted as otherwise reasonable.

This report has its value; but it does not serve to controvert the array of facts relating to the design and building of the dam, all tending to show that it could not have been expected to stand for long after its completion, and, in conjunction with the evidence of witnesses, pointing to more than one sufficient cause of its failure.

Literature.

Glass Technology. A text-book by F. W. HODKIN, B.Sc., A.I.C., and A. COUSEN, M.Sc., A.R.C.S., A.I.C. Constable, London. Pp. xxiii + 551. 42s. net.

THIS is practically the first attempt to produce a full text-book of glass technology in the English language, and as such is to be welcomed. The glass industry has hitherto lacked a satisfactory literature of its own to a remarkable extent, owing, we venture to say, to the very nature and condition of the industry itself, which, until recently, might fairly have been described, so far as this country is concerned, as almost inarticulate. Earlier books on the subject have been on a relatively modest scale, because literature is very scanty, and individual manufacturers refused to furnish information or to allow it to be published when available. The principal difficulty in the past, however, was the fact that the industry had been built up, like most other ancient industries, on an entirely rule-of-thumb basis, and it is only beginning to emerge from that state at the present time. In Germany there has long been a well-developed literature of glass technology, and in recent years the industry has undergone remarkable developments in America. The pressure of this competition, added to the direct effects of war conditions, have forced on the British glass industry a certain degree of progressive activity of which the formation of the Glass Research Association and of the Department of Glass Technology at Sheffield University are the most striking symptoms. The Research Association has unhappily come to an end, but the present book is one of the fruits of the Sheffield effort. It constitutes an attempt to bring together in one volume a brief account of the existing knowledge of glass from the scientific point of view, and a more or less detailed account of the latest types of machines and equipment used in the industry. The result is a large and expensive volume which is useful and valuable, although not entirely successful in either direction.

Perhaps the root of the difficulty is to be found in the statement on the cover of the book to the effect that it is intended as a text-book for "all ranks of those engaged in the production of glassware." This implies an effort to deal with the scientific side of the subject from an extremely elementary standpoint, and entails the introduction of much matter not directly relevant to the subject, such, for instance, as a chapter devoted to pyrometry in which a large amount of historical matter of no direct importance to the glass technologist is included, as well as an elementary account of certain electric instruments. This section is not sufficiently elementary for the reader devoid of previous knowledge of the subject, and yet much too elementary for those who have such knowledge. Criticism of the same nature applies to a number of the illustrations, which are superfluous for those who have even a slight practical knowledge of glass-making. The elimination of such unnecessary portions would have had the advantage of reducing both the bulk and the cost of the volume, thus rendering it more readily accessible to some of those for whom it is ostensibly intended.

Apart from these minor defects, the book can be accepted as a sound statement of existing knowledge and practice. It relies, from the scientific point of view, very largely upon the results of researches carried out at Sheffield by Professor W. E. S. Turner and his school. These researches furnish a satisfactory foundation, while full references to other work are also given, so that the scientifically trained reader will be in a good position to form his own ideas on the basis of experimental fact. That anything like a complete scientific theory of the constitution and behaviour of glass cannot yet be given is no fault of the authors, but it greatly enhances the difficulty of their task. They have overcome, or at times evaded, that difficulty with considerable skill. With regard to the practical side of the subject, the book gives full and accurate accounts of methods and appliances, including the latest developments of machines for glass blowing and drawing, which should prove extremely welcome to all concerned with the industry. The daring and ingenuity which has resulted in the creation of some of the most successful of these appliances, such as the Owens bottle-blowing machine and the Libby-Owens and Fourcault processes for drawing sheet glass, must appeal strongly to anyone conversant with the difficulties which beset the handling of glass. One cannot help realising that the advent of these machines and processes is rapidly revolutionising the entire glass industry, and in these circumstances a thoroughly up-to-date treatment of the new processes, such as the present book provides, is particularly welcome.

BOOKS RECEIVED.

Building Practice. By L. Allen Gerrard. London: Blackie and Son, Ld., 50, Old Bailey, E.C. Price 3s. 6d. net.

Sewage Disposal in India and the East. By G. Bransby Williams. Calcutta: Thacker, Spink and Co., P.O. Box 54. Price 10/8 Rs.

The Production and Measurement of Low Pressures. By F. H. Newman. London: Ernest Benn, Ld., 8, Bouverie-street, E.C. 4. Price 16s. net.

Mechanical Design of Overhead Electrical Transmission Lines. By E. T. Painton. London: Chapman and Hall, Ld., 11, Henrietta-street, W.C. 2. Price 21s. net.

The Management of Marine Engines and Boilers. By Eric Prince. London: Scott, Greenwood and Son, 8, Broadway, Ludgate-hill, E.C. 4. Price 10s. 6d. net.

The Design of Marine Diesel Engines. By A. Buchanan. London: The Association of Engineering and Shipbuilding Draughtsmen, 96, St. George's-square, S.W. 1. Price 2s. net.

Obituary.

CHARLES LIDDELL SIMPSON.

IT is with regret that we have to announce the death of Mr. C. L. Simpson, which took place at his home, 46, Portman Mansions, W. 1, on Thursday, the 12th inst.

Charles Liddell Simpson was the son of the late James Simpson, and like both his father and his grandfather, the late James Simpson—sometime president of the Institution of Civil Engineers—he was from his early days associated with James Simpson and Co., Ld., of Pimlico. He was born in 1862, and received his education at Wellington College. After leaving school in 1880 he spent some months in his father's works, and then proceeded to Hanover, where he attended lectures on machine construction and design at the Royal Technical High School in that city. On his return to England he spent three years in the marine engine shops of the Wallsend Slipway Company, Ld., under Mr. William Boyd.

In 1888 Mr. Simpson joined the firm of James Simpson and Co., Ld., of which in 1896 he became the managing director. He was closely connected with the carrying out and testing of the many large pumping machinery installations which his firm built for water supply undertakings at home, and abroad. When the London works of James Simpson and Co., Ld., were removed to Newark-on-Trent, Mr. Simpson designed, laid out, and superintended the building of the new works, and continued to superintend the manufacture of the water supply pumping plants built by the firm. In 1909 he became a director of John Russell and Co., Ld., of the Alma Tube Works, Walsall, and for many years he took charge of the London business of that firm. Other work which he undertook was the re-equipment and extension of Messrs. Russell's brass works.

During the war period Mr. Simpson became chairman of the Patent Die Castings Company, Ld., a firm which carried out important work connected with the production of alloy castings. Other firms with which Mr. Simpson was associated as director were the Elham Valley Water Company, the Folkestone Waterworks Company, and the Atmospheric Steam Heating Company, Ld. As late as 1923 he acted as consulting engineer to the Folkestone Waterworks Company, and supervised the construction of a new four-million gallon water reservoir and the making of a new adit by means of a Whittaker adit boring plant.

During the last three years Mr. Simpson was obliged gradually to cease his many business activities owing to his indifferent state of health.

THE COUNTING OF ATOMS.

IN the third of his course of four lectures at the Royal Institution on "The Counting of Atoms," Sir Ernest Rutherford stated that the discovery by Faraday in 1833 of the laws controlling the decomposition of solutions by an electric current was an advance in knowledge of far-reaching importance to science, for it first brought to light a simple relation which exists between the atoms of the elements and the charges carried by them in electrolysis. The weight of an element deposited by the passage of a definite quantity of electricity was found to be proportional to the atomic weight of the element divided by a whole number 1, 2, 3 or 4, &c., representing the valency of the element. This could be most simply interpreted by supposing that each ion carried a charge of electricity which was an integral multiple of the charge carried by the hydrogen ion in the electrolysis of water.

From this evidence, Dr. Johnstone Stoney in 1874 suggested that electricity, like matter, was atomic in character, and that all electric charges were integral multiples of a fundamental unit of charge. He supposed that the positive charge carried by the hydrogen ion in water was the smallest unit, and later in 1891 gave the name "electron" to this fundamental quantity, and made a rough estimate of its magnitude. The discovery of the negative electron of small mass and the definite proof that the passage of electricity through gases was due to the transport of charged ions emphasised the importance of measuring the magnitude of the charges carried by them.

Townsend, in 1897, showed that the charge on the ions formed in gases by various agencies was numerically equal to the charge carried by the hydrogen ion in electrolysis, and made the first definite experiments to measure its magnitude by determining the charge on minute drops of water produced under certain conditions. Experiments on drops produced by somewhat different methods were made by Sir J. J. Thomson, H. A. Wilson and others.

The most accurate results were obtained by Professor Millikan between the years 1910–1917 by measuring the charge on a single droplet of oil or of mercury. A single charged drop, the motions of which could be followed by a microscope, was supported in air by the electric field between two parallel plates. Since the weight of the drop was determined by its rate of fall under gravity, the charge on it would be directly measured. By ionising the air surrounding it, one or more of the ions gave up their charge to the drop, and the change in the charge on the drop could be followed. In this way it was found that the charge always altered by an integral multiple of a definite unit which was determined with precision. The actual charge on the drop produced by friction was an integral multiple of this unit.

This unit of charge is numerically equal to the charge carried by the hydrogen ion and by the electron. Knowing its magnitude, the mass of the atom and the Avogado constant can be determined with precision from the electrochemical data. The experiments of Millikan have given a convincing proof of the atomic nature of electricity and an accurate measure of this unit, which is one of the most fundamental in Nature. Using his value, we can fix the mass of the atom of any element with precision.

SIXTY YEARS AGO.

IN our issue of March 17th, 1865, a brief note recorded that Regnault had then in the Press a "new work on vapours." This work, we added, ought to settle all questions in relation to the theory, at least, of expansion. Regnault's results of his investigation into the relationship between the temperature and pressure of steam were published in the Memoirs of the Institute of France in 1847. The new work on "vapours" was presumably the result of his extended researches on the properties of steam. The reference to the theory of expansion may appear somewhat cryptic to-day. It may, therefore, be explained that sixty years ago the economy to be derived from working steam expansively was a subject of much debate. Some denied that there was any economy at all, and elaborate experiments conducted in the United States under the charge of the chief engineer to the Navy did little to suggest that they were wrong. . . . In a closely succeeding paragraph we recorded the formation of "a new and highly important branch of the volunteer service," namely, the Engineer and Railway Staff Corps. This body, we noted, was designed to "undertake the transmission of troops by railway in the most efficient manner," and was to consist of the best known civil engineers and railway managers who would receive commissions as lieutenant-colonels. Colonel M'Murdo had been asked to act as colonel of the new corps and Mr. Bidder had been appointed commandant. The corps is still in existence to-day. Its usefulness was fully demonstrated in August, 1914. . . . In these days when the "all-metal" house is being developed with great rapidity, it is interesting to note that sixty years ago cast iron as a structural material in building work was attracting an increasing amount of attention. In the issue from which we have already quoted attention was called to the fact that the external use of cast iron columns was becoming common in architecture. Examples were given of the employment of the metal for this purpose in some London warehouses and churches, and it was suggested that it might be used for many other objects in building structures besides columns. Then, even as to-day, the tendency to corrosion was recognised as a serious factor militating against the external use of cast iron. It was urged that paint could not be relied upon for protection in exposed positions, as oxidation might go on beneath it. Cast iron, it was recognised, did not rust as readily as wrought iron, but it required only a glance at railings say, fifty years old, to prove that it was very far from being durable. It was suggested that the best protection might be found to be a thin coat of copper deposited electrolytically, although it was admitted that the expense of the electro-bronzing process would be heavy. The durability of iron railings is perhaps greater than was suggested. In Clifford's Inn, off Fleet-street, some wrought iron railings are to be found to-day still in service after a life of over two centuries.

New Dock Equipment on the Clyde.

No. IV.*

PNEUMATIC AND ELECTRIC SERVICES, PRINCE'S AND GRAVING DOCKS, Nos. 1, 2 AND 3.

PRIOR to the installation of the pneumatic plant, which is described in what follows, contractors engaged on the repairs, &c., to vessels in the graving docks of the Clyde Navigation Trust, had to provide their own air-compressing plants, or to obtain their supply from an adjacent shipyard. This arrangement was unsatisfactory in several ways, and in view of the fact that the use of pneumatic tools of every description had become so general, and that compressed air as a form of power was so convenient, the Trustees of the Navigation decided in 1918—before the end of the war—to install a central pneumatic plant. They accordingly instructed Walter Bridges and Co. to prepare a scheme for their consideration. The resulting report, which was dated October 16th, 1918, was based :—(*a*) On the assumption that the total maximum output of the air compressing plant should be 2400 cubic feet of free air per minute compressed to a constant pressure of 105/110 lb. per square inch ; and (*b*) that the air would be supplied to the contractors by meter.

The position proposed for the compressor house was to be adjacent to Graving Dock No. 3—as indicated in Fig. 1 in article No. 1 in this series—that position being chosen as being the most convenient having regard to the importance of a central position for distribution. The report was further based on the proposal that the compressing plant should in the first place consist of two units each capable of compressing 1200 cubic feet of free air per minute to a pressure of 105/110 lb. per square inch, these units being exactly similar in every detail, and that each unit should be electrically driven by an alternating-current motor coupled direct to the compressor. The compressor house was designed for a third unit of similar size to be subsequently installed. The air compressors were to deliver into a common receiver from which it was proposed to take two main pipe lines—one for supplying Nos. 1 and 2 Graving Docks and the other for supplying the two halves of No. 3 Graving Dock.

For the northern section, *i.e.*, the supply to Graving Docks Nos. 1 and 2, the diameter of the pipe from the receiver as far as the No. 2 Dock was to be 5in. diameter, and from thence 4in. diameter to supply compressed air to Graving Dock No. 1. The compressed air was to be delivered to Graving Docks 1 and 2 by two 2½in. branches taken to a ring main in each dock, these ring mains being arranged to be split up when necessary into two independent services by closing a valve at the east end. Each half of each ring main was arranged to pass through a separate rotary meter so that it might be possible, if need arose, for two independent contractors to work from the same service in the same graving dock.

The supply pipe from the receivers to Nos. 3 Graving Dock was to be 5in. diameter, arranged to pass through a tunnel to be driven under the main roadway ramp and to terminate at four meters fixed on the south retaining wall of the ramp. From this point 2½in. ring mains were to be taken through rotary meters to both halves of the dock arranged in a manner similar to that employed for Graving Docks Nos. 1 and 2.

The ring mains in all the four docks were to be carried in the channels at the bottom of each dock. The mains to consist of internally and externally galvanised steel tubes with branches arranged at frequent intervals in the docks. The branches were to be fitted with gun-metal packed gland cocks of the lock-up type.

In the first instance there were to be four of these branches to each dock and each to be furnished with a manifold header for the attachment of flexible for connections to the pneumatic tools. It was proposed that the compressed air should be supplied to the contractors by meter at a pressure of 100 lb. per square inch.

The Trustees, after having considered this report, decided to act upon it in a modified form. They agreed to the size of compressor proposed—*i.e.*, a capacity of 1200 cubic feet of free air per minute—but decided that, in the first instance, only one unit should be installed. The system of ring main distribution as described in the report was adopted, but the manifold header and flexible connections were omitted, and the branch terminal connections made 1in. instead of 1½in. Specifications for the work involved, together with detail drawings, were then prepared, and the work put out to tenders. The successful contractors were Belliss and Morcom, Limited, and the sub-contractors for the motor were the British Thomson-Houston Company, Limited, and for the switchgear the Igranic Electric Company, Limited.

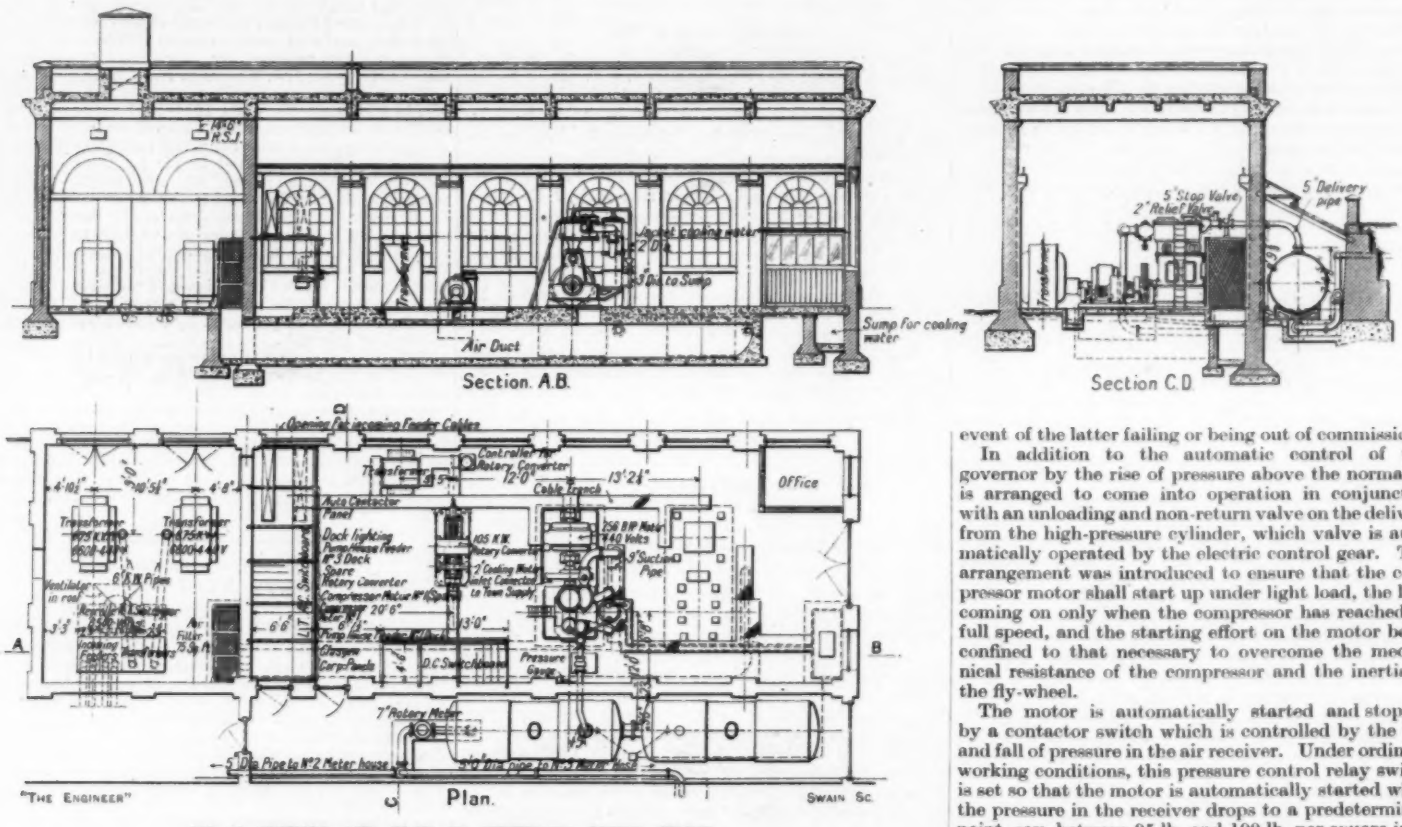


FIG. 14—SECTIONS AND PLAN OF PNEUMATIC POWER HOUSE

The arrangement of the air compressor house is shown in Fig. 14, while an interior giew of it is given in Fig. 15. The air compressor is of the two crank two-stage intercooled type, and is direct coupled to and driven by a 440-volt three-phase 25-cycle wound-rotor motor capable of delivering 250 brake horse-power when running at a speed of 292 revolutions per minute. The diameter of the low-pressure cylinder is 22½in. and of the high-pressure cylinder 13in., and the length of stroke is 11in. The air is delivered to the compressor through a specially designed air filter consisting of a steel frame structure approximately 8ft. long by 9ft. high by 3ft. wide, the panels of which are covered with cocoanut matting held in position by wire netting 1½in. mesh. This screen is fitted in a transformer chamber adjacent to the compressor house which will be referred to later. All the air for the compressor is drawn through this screen, and as the windows of the transformer room are fitted with perforated zinc screens, it—the air—is satisfactorily freed from matters in suspension. Incidentally the transformer house is thoroughly ventilated.

An intercooler is provided between the high and low-pressure cylinder, and it, when supplied with cooling water at a temperature of 65 deg. Fah. to 70 deg. Fah., reduces the temperature of the full quantity of air after passing the low-pressure cylinder to approximately the same temperature as the atmospheric intake air. The question as to what would be the best and most economical manner of supplying the cooling water was carefully gone into, and it was decided for the present, at any rate, to employ water from the Corporation's mains. The quantity required did not warrant the installation of a cooling plant, but we understand that the roof of the building has been designed to be sufficiently strong to support a water tank and cooling towers so that if at some future time additional compressing plant were to be installed and it became desirable to conserve the water, the necessary cooling plant could be added. The delivery from the compressor is taken into two horizontal air receivers each 6ft. diameter by 18ft. long.

An automatic air supply governor is provided on the compressor automatically to put the cylinders in vacuo on the pressure rising above the normal working receiver pressure. This air governor is fitted with a hand adjustable range of control of 15 per cent.—*i.e.*, to operate at any pressure from 95 lb. per square inch to 110 lb. per square inch, and is further arranged to act as an alternative and auxiliary to an automatic electric control which we are about to describe, and under ordinary working conditions is adjusted to operate at a slightly higher pressure than the pressure-operated relay switch on the electric control gear, so as to ensure that it shall come into action in the event of the latter failing or being out of commission.

In addition to the automatic control of this governor by the rise of pressure above the normal, it is arranged to come into operation in conjunction with an unloading and non-return valve on the delivery from the high-pressure cylinder, which valve is automatically operated by the electric control gear. This arrangement was introduced to ensure that the compressor motor shall start up under light load, the load coming on only when the compressor has reached its full speed, and the starting effort on the motor being confined to that necessary to overcome the mechanical resistance of the compressor and the inertia of the fly-wheel.

The motor is automatically started and stopped by a contactor switch which is controlled by the rise and fall of pressure in the air receiver. Under ordinary working conditions, this pressure control relay switch is set so that the motor is automatically started when the pressure in the receiver drops to a predetermined point, say, between 95 lb. and 100 lb. per square inch and the motor stopped when the pressure reaches any predetermined point between 105 lb. and 115 lb. per square inch by the relay switch opening the motor circuit. It is to be understood that the relay switch, which is opened and closed by the pressure in the air receiver, controls the current to the solenoid of the motor stator switch, which switch, in turn, controls the solenoid operating the rotor contactor switches.

The switchgear consists of a stator switch for controlling the mains to the stator and four solenoid-operated switches for the rotor circuit. These solenoids are worked from the alternating current main supply at 440 volts. The motor is of the induction type with wound rotor. It is designed to develop its full load continuously, and, further, to withstand an overload of 25 per cent. for two minutes and 50 per cent. momentarily.

The air meters used for registering the total quantity of air leaving the receivers and also for metering the quantity of air supplied to the purchasers from the distributing mains in the docks, are of the rotary type, as manufactured by the Rotary Meter Company. They are fixed in the high-pressure supply, but the indices are arranged to register in cubic feet of air at atmospheric pressure. An interior view of one of the electric and pneumatic service cubicles is given in Fig. 16.

The plant has been in constant commission since its installation, and has maintained the pneumatic services with reliability and satisfaction. It is most interesting to watch in action. The attendant has nothing whatever to do with the starting or stopping of the machine. He has only to see after the lubrication, &c. Everything else is automatic, and it speaks well both for the design and construction of the various

* No. III. appeared March 13th.

CLYDE NAVIGATION TRUST—INTERIOR OF PNEUMATIC POWER HOUSE

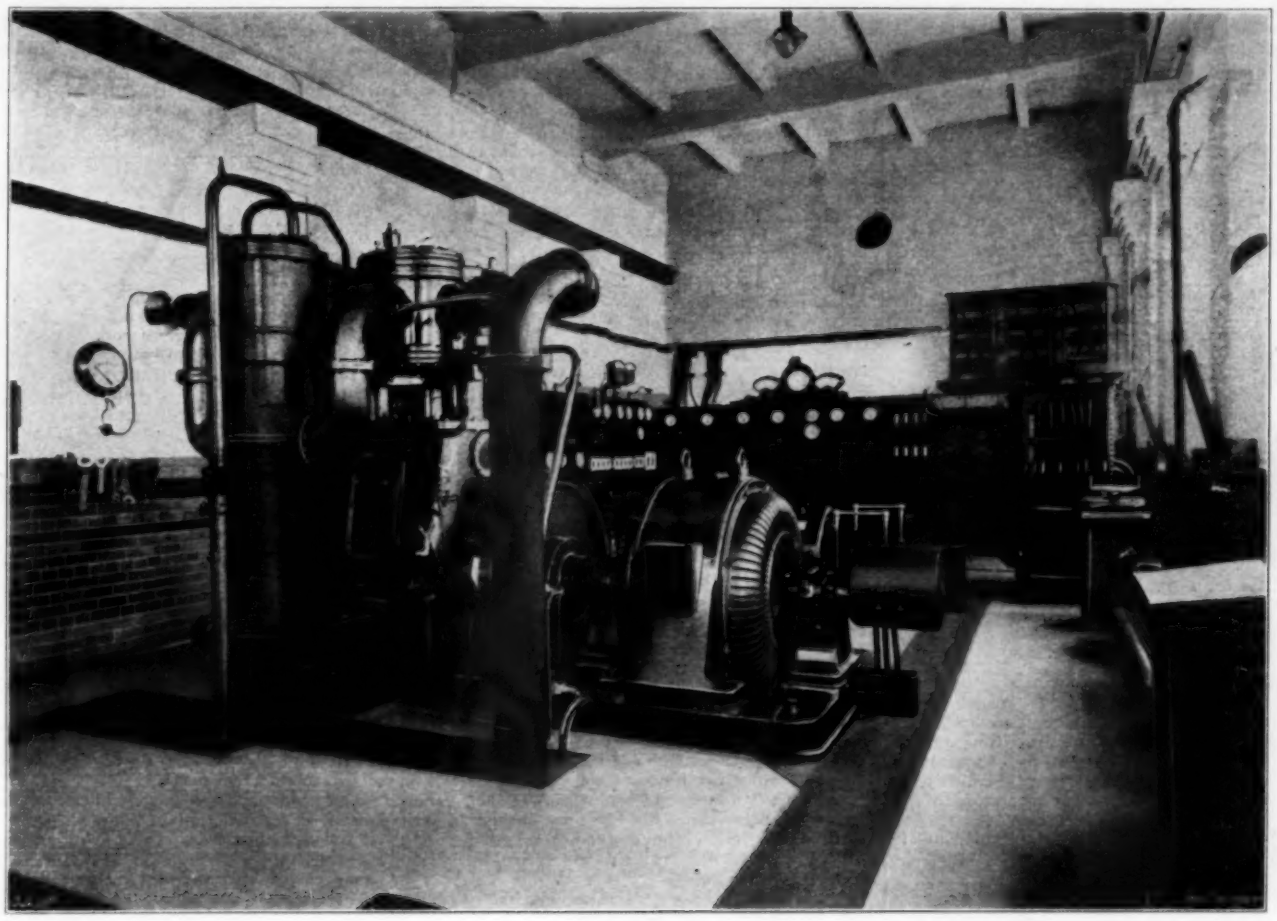


FIG. 15

component machines that no trouble whatever is experienced.

Description of Plant on Trial.

After the plant was installed, the official test made indicated that the machinery, as supplied, was easily capable of carrying out its specified duties. The following are the average hourly readings taken :—

Pressure in receiver	103 lb.
Reading of the meter	1210 cu. ft. of free air
Speed of the compressor	292 revs. per min.
Units absorbed	200
Temperature of air—	
First stage, inlet	56 deg. Fah.
First stage, outlet	261 deg. Fah.
Second stage, inlet	67 deg. Fah.
Intercooler temperature of water, inlet	45 deg. Fah.
Intercooler temperature of water, outlet	68 deg. Fah.
Volumetric efficiency	82.7 per cent.
Mechanical efficiency	86 per cent.
Isothermal efficiency	76 per cent.
Adiabatic efficiency	89 per cent.

There is no doubt whatever that the installation of this compressing plant has been of great service to the Navigation Trustees, and to the ship-repairing and reconditioning contractors. The system of payment by meter so that each contractor knows exactly the volume of air he is using has, we understand, given entire satisfaction.

Electricity Supply.

The arrangements for the supply of electrical energy throughout the various docks, are of a wonderfully complete type. The Glasgow Corporation's high-tension mains run on to the site at two points, namely, the hydraulic power station at Prince's Dock and the pneumatic power station near Graving Dock No. 3. These mains supply three-phase 25-cycle current at 6600 volts. Current at that voltage is likely to be very seldom used by contractors at work on ships in the docks, but it is, as we have seen, used by the Trustees for operating several of their machines. In order to furnish supplies at a lower voltage, not only for operating the Trust's own pumping and other machinery, but also for other power and lighting purposes, two sub-stations have been arranged, one in each of the buildings just mentioned. Each sub-station contains two 675 kilovolt-ampère transformers, which reduce the pressure from 6600 to 440 volts. These, as well as the other transformers which have been mentioned in these articles, were supplied by the British Electric Transformer Company, Limited, of Hayes, Middlesex. They are of the oil-cooled type, and being of that company's well-known standard type do not call for special mention. There are other transformers which reduce the pressure to 250 volts. At the Prince's Dock hydraulic pumping station the switchgear is housed in the pump-room. It was supplied by Reyrolle and Co., Limited. The main switchboards for lighting and power distribution, which are also in the pump-room, were supplied by Ferguson, Pailin, Limited.

For providing direct current for dock and ship purposes, which cannot be obtained from the Corporation mains, two rotary converters have been installed in the Prince's Dock building, and one in the pneumatic power station. The two machines at Prince's Dock are each designed to supply direct current at 250 volts, or, when connected in series, at 500 volts. The pneumatic station machine delivers direct current at 100 volts. The two 250-volt machines and switchgear were made by Crompton and Co., Limited, and the 100-volt machine and switchgear by Bruce Peebles and Co., Limited. All three machines are furnished with automatic means for giving end play to the armature so as to keep the slip rings and commutators in good condition. At the pneumatic power station part of the switchgear is in the transformer room and part in the compressor room. The high-tension controlling switchgear was supplied by Reyrolle and Co., Limited, while the low-tension alternating and direct-current main switchboards were made by Ferguson, Pailin, Limited.

FIG. 16—ELECTRIC AND PNEUMATIC SERVICES CUBICLE

It will be understood therefore that the following currents and voltages, derived from the Corporation mains directly or converted are available :—

Alternating 3-phase, 25-cycle	6600, 440 and 250 volts.
Direct current	100, 250 and 500 volts.

It is therefore unnecessary for generating plant to be run on board any vessel undergoing repair since direct or alternating current of any voltage likely to be required, whether for power, lighting or welding, can be supplied by the Trust.

In the scheme, the consulting engineers also had to take into consideration the whole of the bulk electricity supplies to the docks, not only for the power involved in the reorganisation of the dewatering and pneumatic plants, but generally for the lighting purposes throughout the quays, not only at the present juncture, but with a view to the future—hence their deciding to make the Prince's Dock hydraulic station and the Graving Dock pneumatic power station the electrical sub-stations for the whole of this section of the Clyde Navigation's quays, &c.

The report to the Department of Industry and Commerce of the Irish Free State by Mr. T. M. Batchen, M. Inst. C.E., on the derailment of a passenger train when crossing Owencarrow Viaduct during a gale on January 30th last, suggests that the first vehicle to leave the rails was the third from the engine. Derailment happened despite the strong wheel guard rails, which are raised to 2½in. above the level of the running rails. The side of this coach was hauled for some distance leaning against the iron parapet of the viaduct. At the end of the viaduct there is a length of 134 yards of embankment, in which there are two masonry arches of 40ft. span each. These arches have small parapet walls, 18in. high above rail level, upon which there is a light hand railing, 33in. high. Between the end of the viaduct and the beginning of the small parapet walls over the arches is a space of 47ft., and therein the second vehicle was caught by the gale, thrown against the masonry above the arches and then blown completely over the parapet, and there held in an upside-down position by the couplings. From the evidence of the trainmen and those of the passengers who testified at Mr. Batchen's inquiry, the storm was not unusual, but he says that the portion of the railway west of Kilmacrenan is particularly exposed, and some means must be taken to prevent a recurrence of derailments of this nature.

22,000-Volt Motor Generator Locomotives.

THE idea of employing motor generators on locomotives for the purpose of converting single-phase current into direct current was first put forward in 1902 by Messrs. Mordey and Jenkins, who proposed to employ an induction motor for driving the converter, but at a later date Mr. Ward Leonard advocated a synchronous motor. On account of the weight of the electrical equipment and the subsequent development of single-phase commutator motors, the scheme did not materialise, although attempts have been made to equip single-phase electric trains with rectifiers. For the conditions prevailing on some of the American railway systems, however, the motor generator locomotive appears to be suitable, and it has been reported in the American technical Press that investigations have shown that locomotives of this type that are to be put into service will not be heavier than 3000-volt direct-current engines of corresponding power. The American railways for which these engines are at present being built are the Detroit and Ironton Railway and the New York, Newhaven and Hartford Railway, the latter having ordered seven motor generator engines from the American General Electric Company. These locomotives are designed to collect 11,000-volt, 25-cycle current from the overhead wire, but those for the Detroit and Ironton Railway are to collect single-phase current at a pressure of 22,000 volts, which is twice as great as the highest pressure at present used on American railways. By converting the current on the locomotives, rotary converter sub-stations are, of course, rendered unnecessary, and a much higher trolley pressure than that permissible with direct-current distribution is possible.

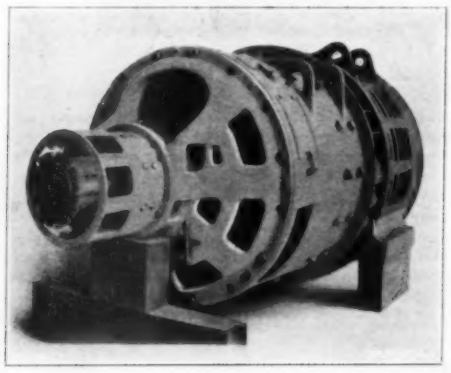


FIG. 3—MOTOR GENERATOR

FIG. 4—TRACTION MOTOR

The mechanical parts for the new engines for the Detroit and Ironton Railway have been designed by the engineers of the Ford Motor Company, and are being made at the company's Highland Park Works, whilst the electrical equipment is being constructed by the American Westinghouse Company. Each engine will be capable of developing 5000 horse-power when running at a speed of 17 miles per hour, and will exert a maximum starting effort of 225,000 lb. on the basis of an axle loading of 42,500 lb. with 33⅓ per cent. adhesion. The normal rating of the engines, however, is 4200 horse-power, and they will develop 3600 horse-power continuously at all speeds between 17 and 25 miles per hour. Each power unit will be arranged for "double-end operation," so that a complete locomotive—see Fig. 7—may consist of one, two or more units, the estimated weight of each unit being 170 tons, and all this weight will be carried on the driving wheels.

The principal reasons for choosing motor generator locomotives may be summarised as follows:—(1) The possibility of employing a high alternating-current distribution pressure; (2) the scheme permits of the use of direct-current motors, which are very robust and occupy relatively small space, and can be made to meet the conditions more readily than other motors; (3) the possibility of simplifying the mechanical parts and of obtaining a reduction in weight of the motors; (4) simple and flexible control; (5) regeneration can be obtained without complication, and the engines can be made to regenerate at any speed between the maximum speed and almost zero speed; (6) the voltage can be controlled without appreciable rheostatic losses, and the engines can be operated continuously at any desired speed; (7) the engines can readily adapt themselves to all changes in gradient; (8) the constant horse-power characteristics enable the locomotives to develop their full capacity under a variety of speed and tractive effort conditions; (9) the inherent voltage regulating effect of the locomotives has a favourable effect on the distribution system; (10) there is little tendency for the driving wheels to start or continue to slip during the accelerating periods, because the voltage impressed across each traction motor while the maximum starting effort is being excited is low, and does not increase if slipping occurs; (11) the ability of the engines to maintain a unity power factor on the system tends to lower the transmission losses; (12) the ability of the engines to work at full load in the same train with any other type of alternating-current locomotive; (13) the possibility of making the engines work at constant speed by separately exciting the fields of the motors; (14) when running the motors with separately excited fields, a large number of constant running speeds can be obtained; and (15) the adaptability of the scheme as regards the design of locomotives with all the weight on the drivers. In short, this type of engine was adopted because it was believed that it would furnish a flexible and reliable means of utilising the power delivered to it by the simple high-voltage alternating-current system.

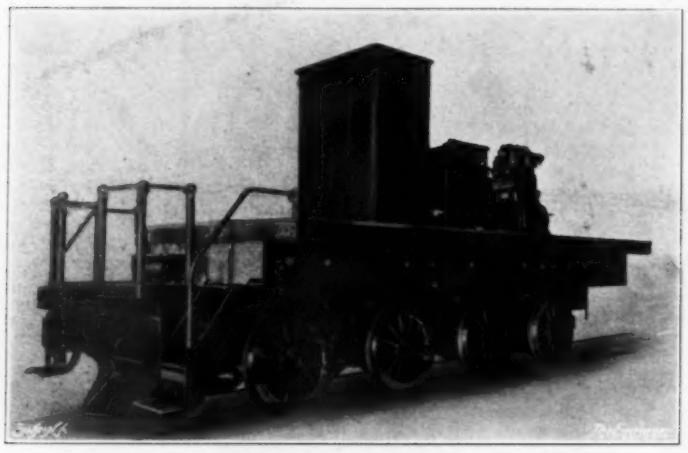


FIG. 1—TRUCK EQUIPPED WITH TRANSFORMER.

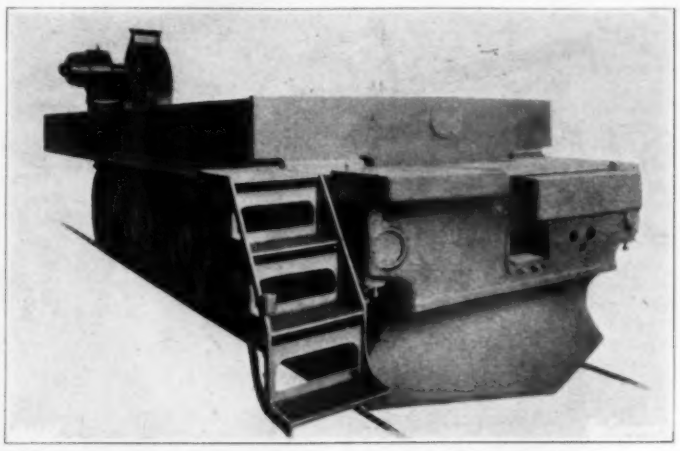


FIG. 2—TRUCK WITH VENTILATING FAN IN POSITION

The motive power units, which are shown in the course of construction in Figs. 2, 3 and 6, will be equipped with a transformer, a direct-current generator driven by a single-phase motor, direct-current series-wound traction motors, and suitable control and auxiliary apparatus. Single-phase current at a pressure of 22,000 volts will be collected from the overhead wire by means of a pantograph current collector, and will be conducted through an oil circuit breaker to the primary side of the transformer, which will reduce the pressure to a value suitable for driving the motor generator set. Direct current at pressures varying from zero up to 600 volts will be supplied by the motor generator to the main traction motors, which will be permanently connected in parallel, and the motors will be capable of sending current back into the line. The transformer, which is to be seen mounted on one of the trucks in Fig. 1, is a two-circuit oil-insulated air-cooled railway transformer rated at 2000 kilovolt-ampères, and designed so that the primary winding may receive current at either 22,000 or 11,000 volts, whilst the secondary winding delivers current at 1250 volts. The high voltage side will be connected between the circuit breaker and earth, and in series with two single-pole double-pole knife switches in such a way that the transformer can be connected to operate on either 22,000 or 11,000 volts by placing the switch on the proper contacts. This arrangement has been adopted so that it may be possible to operate the locomotives on connecting 11,000-volt lines at a later date.

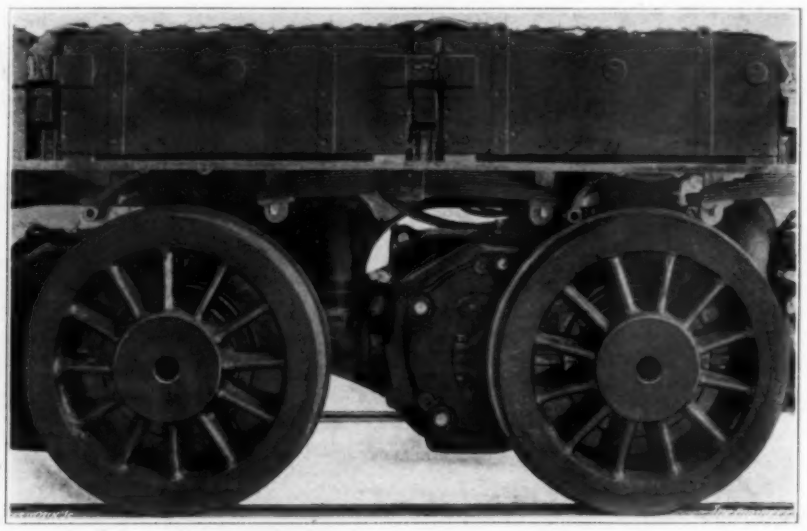


FIG. 5 PORTIONS OF TRUCK CARRYING STORAGE BATTERY

The locomotive motor generator set—see Fig. 3—consists of a 2100 horse-power 25-cycle four-pole

single-phase motor driving a 1500-kilowatt 600-volt 2500 ampère generator at a speed of 750 revolutions per minute. The set is self-contained and will be supported at three points on a truck—as shown in Fig. 6. The shaft of the machine carries the motor rotor, the generator armature and the main exciter, which is rated at 75 kilowatts at 125 volts. At the opposite end of the shaft there is another exciter which serves for exciting the fields of the motors during the regenerating period. The main generator has series differential windings, interpole windings, compensating windings, and a separately excited field. The 75-kilowatt main exciter will be used to excite the alternating current motor field, the generator field, the regenerative exciter field, and to supply power for all the auxiliary motors and for the control circuits, whilst the 25-kilowatt regenerative exciter will

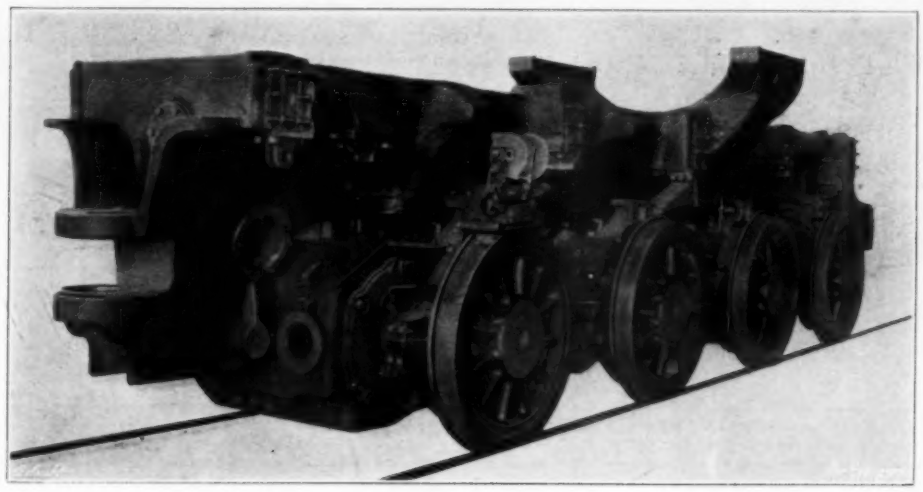


FIG. 8—MOTOR GENERATOR TRUCK

be used to excite the traction motor fields separately, during the regenerative periods and during high-speed motoring periods.

Each of the locomotive traction motors—see Fig. 4—will be capable of developing 225 horse-power continuously when working at a pressure of 600 volts, and will be mounted—as shown in Fig. 5. Each motor will be flexibly connected to a driving axle by means of gearing at each side. A 22-tooth pinion with a 3½in. face will mesh with a 98in. tooth wheel mounted on an extension at each end of the motors. Forty-five normal running speeds will be available between standstill and the maximum running speed during the motoring and regenerating periods, and the speed in both cases will be controlled manually from standstill to 17 miles per hour by regulating the main generator voltage, and from 17 miles per hour to the maximum speed by regulating the field strength of the main traction motors, which will be connected as series excited machines during the motoring period from standstill to 17 miles per hour, and as separately excited motors during the motoring period from 17 miles per hour to the maximum speed. During the regenerating period all the motors will be separately excited.

Whilst the motors are separately excited, regeneration will be obtained at any time by regulating the generator voltage and traction motor field strength, so that the motor voltage will overcome the generator voltage, and so cause the armature current to reverse, thus causing the traction motors to act as generators and to drive the main generator as a motor, which in turn will drive the alternating-current motor and make it return current to the line. When passing from the series excited to the separately excited motor connections or *vice versâ*, a closed circuit arrangement will be utilised, so that the separately excited connections may be completed, while the motors are energised and working at full load as series motors, without interrupting or appreciably changing the value of the motoring tractive effort, either during the change over period or after the separately excited connections have been completed. The closed circuit transition may be utilised advantageously during the motoring period to change from the series connections of the traction motor fields to the separately excited connection when it is desired to increase the speed of the locomotive by weakening the field strength of the traction motors.

As the single-phase driving motor of the main motor generator set is not self starting, the machine will be started and partially accelerated up to speed by supplying direct-current from a battery to the direct-current end of the machine. This battery, which will consist of 60 cells, will also be used for energising the control circuits and for supplying power to the compressor motor at times when the motor generator is not in operation. The motor generator will be run up to approximately 50 per cent. of its full speed by means of its direct-current generator, whilst it will be brought up to full speed with the aid of the alternating current motor.

When starting from rest with a fully loaded train, the traction motors will be operated as series excited machines, the train being accelerated up to the continuous full tractive effort running speed of approximately 17 miles per hour by regulating the main generator voltage by means of the field regulator and a set of 50 ampère 125-volt switches.

If desired, and if the conditions, as regards load and gradient, are suitable, a higher running speed than that obtainable with the series connections, may be obtained by separately exciting the motor fields; for the speed may then be increased by weakening the field strength of the motors, this being accomplished by regulating the regenerative exciter voltage, by means of a field resistance and a set of 5-ampère 125-volt switches. When the train passes over the crest of a hill, and it is desired to maintain a certain constant speed when descending the gradient the traction motors will be made to act as generators by strengthening and properly regulating their fields, whilst, when it is desired to bring the train to rest, more powerful regenerative braking will be utilised, so as to reduce the speed of the train to a very low value before the air brakes are applied. The speed will be decreased to 17 miles per hour by regulating the field strength of the traction motors, lower speeds being obtained by regulating the generator voltage.

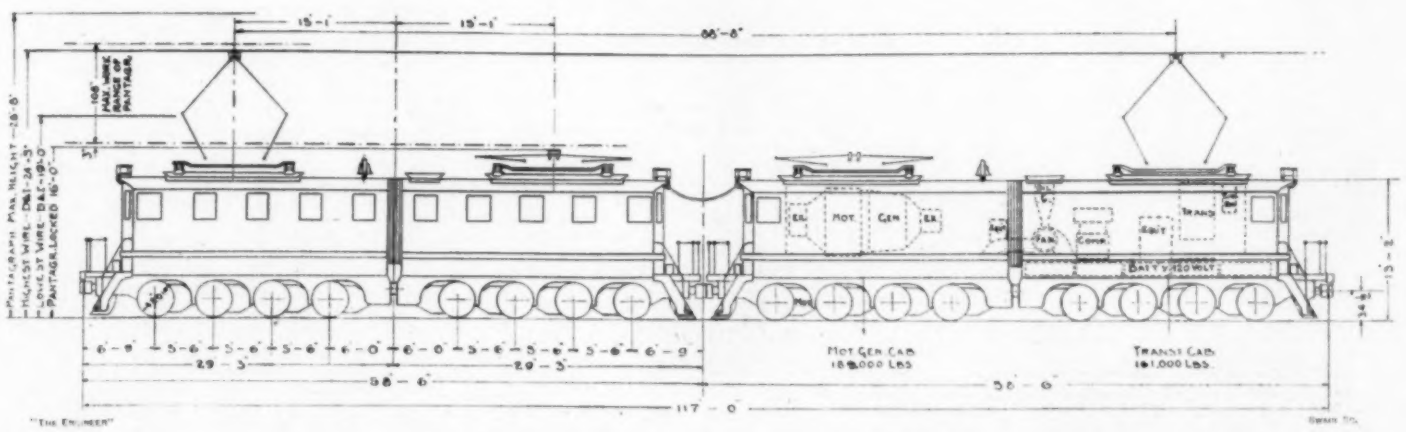


FIG. 7—TWO-UNIT 22,000-VOLT MOTOR GENERATOR LOCOMOTIVE

THE DESIGN OF ROAD BRIDGES.

THE Minister of Transport desires to draw the attention of local authorities to the following observations upon the subject of bridge design:—

There are few features, whether of countryside or town, which attract more notice than the bridges carrying roads over streams and watercourses. Many of them possess historical and archæological interest. Some illustrate the fitting use of local materials by our forefathers, while others provide pleasing examples of modern methods of construction. Of recent years the rapid increase of traffic has impelled highway authorities to undertake the strengthening of many ancient bridges and the building of many additional structures, with the aid of substantial contributions from the Road Fund administered by this Department.

So far as the strength of such structures is concerned your Council will be aware that for some years past certain regulations have been prescribed as a condition of a grant from the Road Fund. But it is possible for a bridge to comply with these regulations and yet fall short of the legitimate expectations of the public in the matter of architectural design and suitability to its surroundings.

Colonel Ashley accordingly wishes to impress upon all local authorities, who are contemplating the alteration of ancient bridges or the erection of new ones, the great importance of securing at the outset reliable expert advice upon the design—not merely from the standpoint of the stability of the structure, but also of its proportions and artistic character. Seeing how long a life may be anticipated for public monuments of this class, it will hardly be questioned that every care should be taken to build bridges, and form their approaches, in a manner which will display the sound judgment of the days in which we live.

With this end in view, the Minister wishes it to be generally known that when receiving applications from local authorities for assistance from the Road Fund, he will require to be satisfied that the foregoing considerations have been taken into account. There is no reason to assume that the observance of these principles will add to the cost of construction, for past experience shows that bridges are more frequently criticised for undue elaboration than for well-proportioned simplicity.

BRITISH STANDARD BRIGHT BOLTS, NUTS AND STUDS.

THE British Engineering Standards Association has just published the following two specifications:—No. 190, 1924: Dimensions for British Standard Whitworth (B.S.W.) Bright Hexagon Bolts, Set Screws and Nuts, Split Pins, Washers and Studs. No. 191, 1924: Dimensions for British Standard Fine (B.S.F.) Bright Hexagon Bolts, Set Screws and Nuts, Split Pins, Washers and Studs.

Both these publications give the overall dimensions for bright hexagon bolt heads, set screws, lock nuts, castle nuts, and slotted nuts, for sizes up to and including 2in., but the dimensions of and tolerances on the screw threads are not included, as they are contained in reports previously issued. In each specification the tensile strength of the material is laid down, that for B.S.W. bolts and nuts having a minimum of 28 tons per square inch and for the B.S.F. series 32 tons per square inch.

The Bright Bolt and Nut Manufacturers' Association, which comprises a very large number of the British bolt manufacturing concerns, has co-operated heartily in the preparation of these specifications, and the Society of Motor Manufacturers and Traders has strongly recommended to its members the use of these standards.

For the convenience of drawing-office, workshops, and garages, the material contained in these two publications has been issued in the form of varnished charts, 21in. by 33in. These charts bear the same numbers as the specifications with the addition of the suffix letter C. The price of each of the specifications is 1s. 2d. post free, and of the varnished charts 1s. 3d. post free, and copies can be obtained from the publications department, B.E.S.A., 28, Victoria-street, London, S.W. 1.

THE Department of Overseas Trade announces that the Commercial Secretary at Copenhagen reports that the Municipality of Copenhagen has announced a competition for a highway bridge over Copenhagen Harbour. Interested United Kingdom firms can obtain further particulars regarding this competition on application to the Department of Overseas Trade, 35, Old Queen-street, London, S.W. 1, quoting reference A.X. 1822.

The Water Supply of the City of Aberdeen.*

By GEORGE MITCHELL, M. Inst. C.E.

THE City of Aberdeen—population 160,000—is supplied with water drawn from the river Dee, 20 miles west of the city. The old works, completed in 1866, consist chiefly of a 12 million gallon storage reservoir, 0.5 acre of slow sand filters, 12.5 miles of brick aqueduct with a capacity of about 8.5 million gallons per diem, service reservoirs, and a hydraulic pumping station. Unfortunately, this aqueduct has been a continuous source of anxiety. In the autumn of 1912 a slight enteric epidemic occurred in the city. This was at first believed to be water-borne, but it is now believed to have been milk-borne. It brought home to the Town Council the urgency of immediately improving the water supply. A scheme, carried out to put matters temporarily on a safe footing, included sterilising the water by quick-lime, improving the storage reservoir, and the construction of 2 acres of slow sand filters. The water supply was lined from 1914 to 1916.

In 1916 the Town Council obtained powers to carry out a new scheme, estimated to cost £1,125,000, and the work was commenced in 1920. This scheme is designed to supply an estimated future population of 240,000 with 40 gallons per head per day. A new intake and screening chamber and a 60in. intake conduit were constructed; also a 6ft. by 3ft. conduit leading to a new 24 million gallon concrete storage reservoir. The walls of the reservoir were constructed in 30ft. lengths, with joggled ends connected by steel plates. The asphalted floor is underdrained to prevent uplifting pressure. The reservoir is divided into four bays by means of reinforced concrete baffle walls. The outlet and by-pass pipes are 48in. in diameter and are of reinforced concrete. Three new filter beds of a total area of 1.4 acre were constructed. These are of the ordinary slow sand type, but they are cleaned by squeegeeing instead of by scraping. It is believed that this system of filtration will be very suitable for a clear water like the Dee. It produces a thickened film less liable to rupture, it keeps the sand of a constant thickness, and the filters ripen quicker. The filter beds, when all in use, can filter the present average day's supply at the standard rate of filtration. From experience at Aberdeen and elsewhere it is believed that most waters can be efficiently filtered at rates much exceeding the standard rate, and that the present area of filters will suffice for a long time to come. No additional liming plant was put down, and it is not intended to lime the water in the future. The old liming plant will be available as an emergency purification plant.

The new aqueduct has a total length of 17.4 miles. It will have, in conjunction with 9.6 miles of the old aqueduct which will be reconstructed in the future, a capacity of 14 million gallons per diem. In the first instance, however, it will have a capacity of about 11 million gallons. The western 2.7 miles and the eastern 5.1 miles will have a diameter of 46in., and the central 9.6 miles will have a diameter of 38in. There will thus be a flat hydraulic gradient at the ends and a steeper hydraulic gradient in the centre portion. As this aqueduct is essentially a single-line aqueduct with comparatively little reservoir capacity at its city end, special precautions were taken in its design. For most of the length competitive prices were got for the construction of the pressure sections in cast iron and steel pipes lined with concrete, and in reinforced concrete pipes. All things considered, reinforced concrete pipes proved to be the most expensive.

The water entering the aqueduct is measured by a Venturi meter of the water column type. The section—0.7 mile—adjacent to the filters is a concrete conduit of horseshoe section, 5ft. 3in. by 3ft. 8in. The next section—2 miles—consists of 48in. steel pipes, lined with ⅞in. of cement mortar applied by hand. There has been a long experience of similar pipe in America of somewhat smaller size. There is little apparent economy in using the cement lining, as for the same cost a larger unlined pipe could be provided having the same probable ultimate discharging capacity. The cement lining, however, gives greater certainty as to the ultimate capacity, preserves the metal, is cleaner, and provides considerable additional stiffness.

The steel pipes are in 20ft. to 25ft. lengths, constructed of $^{7}/_{16}$in. mild steel plates, and were delivered without any coating. The outside was thoroughly cleaned and painted with one coat of bitumastic and one coat of bitumastic enamel, applied hot. The pipe sockets were 4½in. deep and were filled partly with hard-caulked cement mortar and partly with lead wool, 1½in. deep. The joints were tested by means of a tester covering the inside of the joint, into which water was pumped under pressure. The next section comprised 1.5 mile of 48in. and 46in. steel pipes, $^{9}/_{16}$in. thick. These were coated outside with "Mexphalte," and were given two wrappings of hessian cloth. They were lined with ⅞in. of cement mortar applied by hand. The depth of lead used in the pipe joints in this case was 2½in. The last section of steel pipes let was the central section of 9.6 miles of 40in. pipes. These were constructed of $^{7}/_{16}$in. plates and were wrapped outside with "Mexphalte" and hessian cloth. They were lined by the centrifugal process with 1in. of 2 to 1 cement mortar. One-third of the pipes had the mortar mixed inside the pipes by spinning. In the case of the rest of the pipes, the mortar was mixed outside the pipes by a special machine. As compressed air was to be used on the works for other purposes, it was decided to test the pipe line in lengths of about 0.2 mile by compressed air before the trench was refilled.

Three miles of the aqueduct consist of 48in. cast iron pipes lined by the centrifugal process with 1in. of 2 to 1 cement mortar. Lead wire, 2½in. deep, was used for jointing, the sockets being 3½in. deep. These pipes also were tested by means of compressed air. It is essential in the case of large cast iron pipes that not only the joints, but the pipes themselves be tested in the trench before covering up. The stop valves were of standard diameters, and were made nearly the full size of the pipes, as the fall available was very small. Automatic shut-off valves were fixed at two points. Air valves are of the usual double ball type. The easternmost section—0.6 mile—of the aqueduct is a 48in. diameter concrete conduit working under a few feet of water pressure.

The machinery of the Cults steam pumping station was scrapped, and electrically driven centrifugal pumps were installed in duplicate.

A circular covered service reservoir of a capacity of 7 million gallons was constructed. The walls are of plain concrete with expansion joints. The roof is of the ordinary reinforced concrete beam-and-slab construction, covered with asphalt, and is supported by plain concrete piers. The outlet pipe is 30in. in diameter. It is coupled to a 24in. main, 3½ miles long, which formerly fed the Cattofield low service reservoir—2.5 million gallons—and this main thus becomes the leading main of a new distribution zone. The Cattofield reservoir will be used in the future principally as a booster reservoir for the low service zone, whilst also serving a small district of its own.

The cost of the works carried out exceeded £900,000.

* Abstract of a paper to be brought forward for discussion at the Institution of Civil Engineers.

The Ports of America and Europe as Seen by an Australian.

IN the report for the year ended June 30th, 1924, of the Sydney Harbour Trust Commissioners, which has recently reached us, there is an interesting *résumé* of a report made by Mr. W. E. Adams, M. Inst. C.E., the Chief Engineer to the Trust, on a round of inspections which he made last year of various harbours in the United States and in Europe. The report is of an instructive character, and we feel sure that a summary of it will be of interest to our readers.

The tour of inspection, which began on January 30th last year, and occupied six months, included visits to San Francisco, Wilmington, San Pedro—the port of Los Angeles—Chicago, New York, Philadelphia, Southampton, London, Glasgow, the River Clyde, Leith, Rosyth, Harwich, the Hook of Holland, Rotterdam, Amsterdam, Hamburg, Newhaven, Dieppe, Cherbourg, Manchester, Liverpool, Quebec, Montreal, Toronto, Vancouver, Victoria, Honolulu and Auckland.

It is perhaps hardly to be wondered at, having regard to its excellence in many respects, to find Mr. Adams prefacing his remarks by a eulogy of his own port—Sydney. He says: "The first and last impression that would, I think, always be made on a critical observer from Sydney on visiting the above-mentioned ports for the first time are the many and unrivalled advantages possessed by the port of Sydney over all others. Our harbour is a natural one. It is commodious, but not too large; its waters are clean and clear; its entrance is both wide and deep, and so placed as to form a perfect shelter from the sea. The largest vessels afloat could enter at any state of the tide, whereas even at New York the largest do not enter at less than half tide; the tidal rise at Sydney is small, and does not inconvenience shipping as it does in other parts of the world, whilst the current in the vicinity of our wharves is negligible. Our waters are free from the obstructions to navigation so often met with elsewhere; fogs seldom cause delay to shipping; and blockage by ice is, of course, unknown. Adverse winds or stormy weather never prevent overseas vessels from arriving or departing. In addition to these natural advantages, so great when compared with conditions elsewhere, I am able to add, with full knowledge of the situation, that the wharfage, shipping and transport facilities are well abreast of the best met with abroad, and superior to the majority. In comparison, our wharves are excellently well maintained and clean."

In discussing the provision of cargo-handling appliances as a factor necessary to the proper equipment of a port—other than those in use for grain, coal and ore—Mr. Adams remarks that it is a question upon which expert opinion is by no means unanimous. At neither San Francisco, New York, nor Philadelphia are there, he remarks, any such appliances outside the cargo sheds at present in use, though he goes on to say that he understands that it is intended to equip some of the new Staten Island jetties at New York with revolving half gantry electric cranes. At British and continental ports he saw numerous wharf cranes in use, and it was freely admitted with regard to them that, though they did not directly pay interest on capital cost, maintenance and wages, they were indispensable and paid indirectly. That was true, Mr. Adams explains, partly, at least, because, where cranes existed in great numbers, canals were numerous, and barges, not being equipped with derricks, required cranes on the wharves to load and unload them. "Some of the canal barges on the Continent, known as 'Rhine Arks,' carry," he continues, "as much as 5000 tons of cargo. These are not equipped with derricks, one reason being that the have to pass under numerous low bridges. Although wharf cranes are at present largely confined to ports adjacent to canals or to special usages, I think that the time is not far distant when they will be adopted—but less numerously—at other than canal ports. I consider that at this port (Sydney) it is desirable to increase the number of wharf cranes with which the wharves are at present equipped, now that they are obtainable at more reasonable prices."

Nowhere, excepting at Philadelphia, did Mr. Adams find mechanical appliances in the cargo sheds for handling or stacking goods, though, he says: "There were lifts, of course, in two-storey sheds; and in several instances I saw a few electrically operated stacking jiggers and slat conveyors, the latter used only for carrying passengers' luggage, either aboard ship or ashore. This method is desirable, since it saves luggage from being knocked about in slings or in sliding down a chute. In some ports electrically operated trucks and trailers are used to convey cargo to and from the ships' slings, but even that practice is far from being general. The almost entire absence of stacking and handling machinery in the cargo sheds seemed to me very remarkable, but no adequate explanation of its absence was given at any port. Nowhere did I see anything comparable with the small bridge cranes with which some of our sheds have already been equipped, and with which it is the intention of the Commissioners to equip all suitable sheds. In this respect we are well in advance of any of the ports visited."

Mr. Adams was much interested in the amount of space, or waterway, allowed between jetties at ports frequented by very large vessels, which, as he says, is a matter of importance in a growing port like that of Sydney, in which the increase in the size of vessels must be provided for well in advance of their advent. At Walsh Bay, the Trust has, he points out, provided a width of 225ft. between jetties 600ft. in length, designed for overseas shipping. That dimension, he says, compares favourably with the provision made at San Francisco—where all the wharfage consists of jetties—at the berths used by the largest vessels trading to the port, but he goes on to remark that the tidal current is swift in the bay of San Francisco, and on account of its great water area the wharfage is much exposed to high winds. The adverse combination of these two elements has developed the skill of the pilots and tug masters to a high degree. It was, to him, a revelation and a pleasure to watch the unerring berthing of big ships is such comparatively narrow spaces.

Then he adds: "At New York, to which the largest vessels afloat ply, the jetties range in length from 700ft. to 1000ft., and from 60ft. to 125ft. in width; while the clear waterway between them varies from 142ft. to 246ft. There are only two cases on the Manhattan Island frontage in which the width of waterway exceeds 246ft. It was a great surprise to me to find the jetties at New York so narrow and so closely packed together. Seeing that the largest vessels of the world trade there, I had expected to find very much more room left for them to manœuvre into place. The physical conditions opposed to berthing vessels at New York are rather worse than at San Francisco. The exposure to strong winds is about equal, but the ebb current velocity in the Hudson River is at times far greater than the tidal current at San Francisco. In addition, the Hudson is narrow compared with the bay of San Francisco, and the traffic across and up and down the river is enormous. Yet, in spite of adverse conditions and great traffic congestion, the largest ships are seldom, if ever, delayed by wind or tide in making their berths, which speaks volumes for the practical skill of the pilots and tug masters, as manifested in the handling of such unwieldy vessels in confined spaces."

Mr. Adams comments favourably on the decision made in 1912 by the Sydney Harbour Trust Commissioners—acting on the advice of Mr. H. D. Walsh, M. Inst. C.E., Mr. Adams' predecessor in office—not to adopt the ordinary class of reinforced concrete construction in Sydney. The wisdom of that decision is, he says, fully borne out by his own observation and experiences, both everywhere abroad and at Sydney itself. That type of wharf construction has, he asserts, "turned out to be less satisfactory than had been anticipated by its advocates, and may be said to be still in its experimental stage for marine work," and, he adds, "We have in Australia the great advantage of the best of all hardwoods, very durable and suitable for wharf and jetty construction, also the turpentine pile (*Syncarpia laurifolia*), which is durable out of water and also able to resist marine borers for periods varying from thirty to forty years. Our great advantage in this respect will be more fully realised when I point out that timber piles available in most other parts of the world are either of pine or fir; and even when creosoted they cannot be relied on to last for more than from five to ten years."

The finest jetty which Mr. Adams saw on his travels was, he says, the Ballantyne Pier at Vancouver, B.C., which cost £1,500,000, and is 340ft. wide and 1200ft. long. That, he adds, "is the same length as our Jones Bay jetty, but 80ft. wider. Neither at San Francisco nor at New York have they such fine jetties as are at Woolloomooloo Bay, Walsh Bay, and Jones Bay."

The concluding paragraphs of the *résumé* of Mr. Adams' report are as follows:—

"I paid particular attention to the ferry services abroad. Point for point comparisons cannot be made, because the conditions are so widely different at the various ports. In the United States and Canada the boats are usually very much larger than ours and often carry both passengers and vehicles, whilst the distances run are greater. Nevertheless, in so far as comparison is possible, I found the Sydney methods of handling the traffic at the ferry wharves as good as the very best abroad, and entirely suitable for our conditions. Our ferry steamers also by comparison are excellent and well maintained. They are quite in a class by themselves, compared with similar boats at the ports visited by me, both in Great Britain and Europe.

"The sanitary conditions of our wharves I found by comparison to be superior to anything I saw abroad. At San Francisco, New York, and many other large seaports the sewage from the cities is discharged directly into the harbours, consequently the waters are polluted, dirty and evil-smelling, and also littered with flotsam and jetsam, and refuse oil from vessels.

"Nowhere else did I find the unremitting precautions taken here (Sydney) for the prevention of access of rats to the wharves and cargo sheds or for their systematic destruction."

THE INSTITUTION OF NAVAL ARCHITECTS.

As previously announced, the annual meetings of the Institution of Naval Architects will be held in the Lecture Hall of the Royal Society of Arts, John-street, Adelphi, London, W.C. 2, on Wednesday, Thursday and Friday, April 1st to 3rd inclusive.

The following programme has been arranged:—On the Wednesday morning at 11 o'clock the meeting will be opened with the reading of the annual report of the Council, after which the president, officers and Council for the ensuing year will be elected. The president—the Duke of Northumberland—will then deliver his opening address. The following papers will then be read and discussed:—(1) "Relative Commercial Efficiency of Internal Combustion and Steam Engines for High-speed Passenger Vessels," by Sir John Biles; (2) "Japan's Contribution to Naval Architecture," by Professor F. P. Purvis; and (3) "Analysis of Professor Sir John H. Biles's Paper on H.M.S. Wolf Experiments," by Myn. G. H. Hoffmann, of Delft University. There will be no afternoon session, and the

Institution Dinner will be held at 7.30 p.m. in the Grand Hall of the Connaught Rooms, Great Queen-street.

On the Thursday the morning session will be opened at 11 a.m., and the following papers will be read and discussed :—(4) "Wake Propeller Coefficients," by Admiral D. W. Taylor, U.S.N. ; (5) "Form Effects and Form Resistance of Ships," by Mr. W. G. A. Perring ; and (6) "A Suggested Method of Increasing the Efficiency of the Screw Propeller," by Mr. Walter Pollock. In the afternoon at 3 o'clock the following papers will be taken :—(7) "Stresses in Rectangular Plates Clamped at their Edges and Loaded with a Uniformly Distributed Pressure," by Professor C. E. Inglis ; (8) "Notes on the Rolling of Ships," by Mr. G. Vedeler ; and (9) "Model Experiments with Anti-rolling Tanks," by Mr. H. J. R. Biles. At the evening session, which opens at 8 o'clock, (10) the "Second Report of the Marine Oil Engine Trials Committee" will be considered.

On the Friday morning, at 11 o'clock, after the transaction of some business, the following papers will be read and discussed :—(11) "Tonnage Legislation and its Application to the Measurements of Ships," by Mr. E. W. Blocksidge ; (12) "Influence of Trading Conditions on the Design of Intermediate Passenger Vessels," by Mr. W. G. Cleghorn ; and (13) "Stability and Seaworthiness," by Mr. C. Frodsham Holt. For the afternoon session, which opens at 3 p.m., only one paper is down for consideration. It is :—(14) "The Propulsive Performance of the Corrugated Ship," by Messrs. A. H. Haver and E. V. Telfer.

CONTRACTS.

HOWDEN-LJUNGSTROM AIR PREHEATERS (LAND), Ltd., informs us that it is delivering a large number of preheaters to the North Metropolitan Electric Power Supply Company's stations at Willesden and Brimsdown.

WE are informed by Fawcett, Preston and Co., Ld., of Liverpool, that they have secured the contract for the erection of the beet sugar factory about to be installed at Ipswich, as also for the manufacture of a large portion of the machinery to be installed in it, including vacuum pans, vacuum and other pumping engines, crystallisers. The same firm has also in hand a quantity of machinery for the sugar factory which is being erected at Ely.

SCHOLARSHIP IN MINING.—The Council of the Institution of Mining Engineers has awarded the "Mavor and Coulson" Travelling Post-graduate Scholarship of £250 for 1925-26 to Lancelot John Barraclough (Burton-on-Trent), Bachelor of Science (Mining) of Birmingham University. James Fairley Pedelty, Honours B.Sc. (Mining) of the University of Durham, secured the position of *proxime accessit*. The successful candidate is required to devote one year to the special study by underground investigations of the methods practised in the actual mining of coal and in the transport of coal from the face to the main mechanical haulage ; to follow a pre-arranged itinerary specifying the collieries to be visited, subject to the condition that not more than one month shall be spent at any individual colliery. A candidate who knows a foreign language may be required to spend not less than three months on work on the Continent of Europe. If Canada or the United States of America is included in the itinerary, an additional sum of £50 will be paid to the candidate.

VISIT TO A YORKSHIRE IRONWORKS.—On Saturday, March 7th, the Sheffield and District and East Midland branches of the Institute of British Foundrymen visited the ironworks of Newton, Chambers and Co., Ld., at Thorncliffe, near Sheffield. About one hundred and fifty members were present. They met near one of the firm's collieries, Thorncliffe Drift, passed the research and general laboratories to one of the batteries of by-product ovens, where they saw an oven pushed and refilled. This battery consists of forty ovens of the Semet-Solvay type. The by-product plant, where benzole and sulphate of ammonia and various oils and tars are extracted, was also inspected. From the coke ovens the party proceeded to the blast-furnaces, where a cast of the special "Thorncliffe" foundry iron was witnessed. The power-house, which contains three 1000-kilowatt National gas engines driven by waste blast-furnace gas, was then examined, and from there the party proceeded to the foundries, which consist of one building, 600ft. wide by 400ft. long, of fifteen bays of 50ft. and 33ft. spans. They are served by four cupolas, each melting 10 tons per hour. A Beardsley and Piper sand-slinging machine was then seen in operation, as was also a centrifugal-type sand-cutting machine electrically driven and propelled by its own motor the full length of the shop. This machine, though extensively used in America, is the only one of its kind in operation in this country. The large machine moulding bay was a source of great interest. In this bay are two 500-ton sand bins, each with sand elevators feeding the top and bottom part machines respectively. The pattern shops and the various machine shops were then inspected, and particular interest was evinced in the mass production methods of machining and drilling of tank plates, of which the firm is the largest maker in the country. Owing to lack of time it was not possible to visit the steel constructional shops, the light castings fitting and assembling shops, nor the Izal disinfectant works. The party was entertained at tea, when Mr. T. V. Miles, the general manager of the ironworks, welcomed the representatives of the branches. After tea Mr. R. A. Miles, president of the Lancashire Branch, gave a very interesting lecture on "Spun Pipes."

MANCHESTER STEAM USERS' ASSOCIATION.—In presenting the seventieth annual report which deals with the activities of the Manchester Steam Users' Association during the past year, the Committee congratulates the members upon the steady and satisfactory progress which continues to be made. The total number of examinations made during the year was 25,412, of which 11,517 were "internal," "flue," and "entire." The Committee cannot too strongly emphasise the important fact that it is only by a system of faithful scientific inspection that immunity from explosion can be secured, and it is to this point the Committee repeatedly and consistently directs attention and thus continues in pursuance of the policy which actuated the founders of the Association. Shortly after the last annual meeting the Home Office introduced to Parliament a new Factory Bill containing provisions which appeared to threaten increased interference in the working of factories. Many industrial interests have prepared protests against the Bill. It was therefore deemed desirable to subject those clauses of the Bill dealing with boilers to a careful analysis. This was undertaken by the chief engineer of the Association, and the result was published in his memorandum issued to members a few months since. Since the publication of its last report the Association has recorded the occurrence, outside its ranks, of thirty-four explosions in the United Kingdom. These resulted in the killing of nine persons and injury to twenty-nine others. Nine of these explosions, by which two persons were killed and fourteen others injured, may be termed "boiler explosions proper," while the remaining twenty-five, killing seven persons and injuring fifteen others, may be termed "miscellaneous" explosions, *i.e.*, those arising from steam pipes, stop valves, kiers, drying cylinders, bakers' ovens, &c.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Unsatisfactory Outlook.

THE outlook in the iron and steel industries of the Midlands and Staffordshire is far from satisfactory, and hope of an early improvement in business is gradually weakening. On 'Change in Birmingham to-day—Thursday—business was again of extremely small dimensions. The condition of weakness in prices which exists naturally discourages anything like forward buying, and this condition unfortunately applies alike to finished and unfinished material. Though many producers make every effort to maintain quotations others yield to pressure, and quotations are merely nominal. Consumptive requirements show no tendency to increase, and lack of confidence adversely affects the general market tone.

Steel.

In the steel trade prospects are a little brighter in some respects. The amount of constructional work coming forward is encouraging, tenders being invited for bridges, works enlargements, and a wide variety of construction. A number of factory extensions are in progress, and local constructors are getting decidedly busier. In the raw material department, however, the position is so serious that 700 Black Country steel workers have been discharged. A common complaint in the steel trade is the small tonnages ordered, covering a wide range of products, which militates against large production. Mills are dependent almost on day-to-day orders. Prices continue fairly steady, £8 15s. being about the market price for angles and joists. This figure could, however, be shaded for an attractive order. Small steel bars rolled from continental billets have receded to £8 15s., though some mills refuse to entertain less than £9. Soft billets are quoted down to £7 by a few makers at home but without much response. Foreign competition is keen from the price point of view, although the Belgians are not pressing their products on the market with quite as much energy as at the beginning of the year. Prices are severely competitive, billets being quoted at £6 5s., and wire rods at £6 15s. f.o.b. Antwerp. The latter price is a low figure, very much underselling English steel, though the quality is not considered dependable. Comparatively good demands from the stamping trades call exclusively for British steel, the cheaper Belgian quality not being regarded as suitable for these purposes. The production of steel ingots and castings last month amounted to 646,400 tons, or an increase of 41,300 tons over January—when production was affected by the New Year holidays. Production in February, 1924, amounted to 767,600 tons.

Seven Hundred Steel Workers Suspended.

In consequence of the continued depression in the steel and shipping industries it was found necessary on Saturday last by Alfred Hickman, Ld., Springvale Steel Works, Bilston, South Staffordshire, to suspend 700 workers in the Bessemer department, and certain mills. This is rather a serious matter, for the district has already been badly hit this year by the closing down of the Mars Ironworks, following the decision of George Adams and Sons to go out of business altogether.

Raw Iron.

There is no improvement in the raw iron situation in this district and one Derbyshire furnace has been blown out. Unless demand improves in the near future output must be curtailed in other directions. Some of the Northamptonshire smelters say the position of stocks gives them no anxiety. That can hardly reflect the general experience, however. The inference to be drawn from the attitude of some sellers on 'Change in Birmingham to-day was that they are bent upon seeking safety even at a further sacrifice. Values have weakened to £3 12s. 6d. for Northampton No. 3, Derbyshire being easily obtainable at £3 17s. 6d. Forge is quoted Northamptonshire, £3 8s. to £3 9s., and Derbyshire £3 15s. Weak coke is an important element, as it encourages pressure for lower prices on the part of the consumers. There is an impression that the basis of 16s. 9d. will be definitely reduced next month. It is of interest, in view of the present situation in the industry, to note that the amount of pig iron produced in February was 534,100 tons, compared with 574,500 tons in January, and 612,700 tons in February, 1924. The daily rate was thus slightly higher in February than in January—19,075 tons, compared with 18,532. The production includes 179,300 tons of hematite, 160,600 tons of basic, 132,400 tons of foundry, and 30,200 tons of forge pig iron. The furnaces in blast at the end of the month numbered 164, a net decrease of eight since the beginning of the month, three furnaces having been blown in and eleven damped down or blown out.

Finished Iron.

The Staffordshire finished iron trade gives little indication of improvement, a number of the works being almost without employment. The makers of best iron, however, are still favoured, having very good orders for marked bars and superior brands of special quality. They have no difficulty in maintaining the £15 standard. Crown bars quoted £12 15s., and nut and bolt and fencing bars quoted £11 15s., are practically a drug on the market. What little material is required of this class is obtained from the Continent. Staffordshire mills find a substitute by taking a share of the steel re-rolling business. The steel re-rollers complain strongly of the wide variety of products, owing to the small tonnages placed. The tube trade is taking fair quantities of iron strip for which the price is £13 2s. 6d. German bright rolled strip of thin gauges is still coming in to a somewhat disconcerting extent.

Galvanised Sheets.

The demand for galvanised corrugated sheets does not improve, and prices remain weak. The £16 10s. level for sheets of 24-gauge is only maintained with difficulty. Large Welsh makers have been, and are prepared to cut prices severely to secure large orders. Midland mills are not disposed to compete for business on the basis to which these makers have reduced their prices. Difficulty is experienced in obtaining more than small local orders at anything above £16 5s. Black sheets are in very fair demand, meeting with a wide variety of uses, especially in motor construction. Good quantities are taken also for hollow-ware purposes. The tin-plate industry shows a little improvement. Nothing has come of the further negotiations in the trade, except that the deadlock with regard to wasters has been removed. Stock wasters 20 by 14 will remain at the basis price of 19s. 3d. f.o.t.: other sizes are reduced 10½d. as from February 25th. Buyers and sellers now know where they are, but there is little freedom about business. The trade in primes is likewise very quiet. Some of the mills are still unprepared to accept orders at the minimum.

Coal and Iron Trades.

Mr. F. C. Ryland, president of the Birmingham Exchange, at the annual meeting on March 12th, reviewed conditions in the coal and iron trades. One could not fail to be impressed, he said, by the coal output figures. In 1913 the amount of coal raised was 287,430,000 tons ; in 1923 the amount was 276,000,000 tons ; and in 1924 it was 269,134,000 tons. These figures were the more impressive when the increased capacity for both production and consumption were taken into consideration. In 1923 the Ruhr occupation gave a stimulus to exportation, but that impulse weakened in the latter half of the year, and disappeared in 1924. The exports to Germany, the Netherlands, Belgium, France and Italy were 54,525,000 tons in 1923, and 34,139,000 tons in 1924. Such a serious falling off in the demand from these countries could not be recovered in other directions, and in the circumstances it was hardly surprising that there was depression in the coal trade. Regarding production costs, he said they would not come down until the miner realised that he must give a bigger output, which in the end meant better value for the money he was earning. The financial results of last year's working of the collieries of the country were doleful. Under the new agreement, which came into force in May, of the divisible proceeds, 98.12 per cent. went to wages, and 1.88 per cent. to profits. During this period of eight months the following districts showed losses :—Scotland, £220,706 ; Northumberland, £156,802 ; South Wales, £854,026 ; Lancashire, Cheshire and North Staffordshire, £123,000 ; South Staffordshire and Salop, £376 ; Cumberland, £125,314 ; and Kent, £13,606. The position was serious. With regard to pig iron, Mr. Ryland said this section of the trade had also experienced a bad year. With their greatly increased power of consumption they needed larger outputs at lessened costs to enable the consuming works to take the iron ; but with expensive fuel, high taxes, and costly transport, it was difficult to see how lower costs could be obtained. The number of furnaces in blast fell from 204 in January, 1924, to 173 in November. The imports of iron and steel and manufactures thereof totalled over 2½ million tons ; but that could not be taken as all loss to the workers, because much of the material was more or less raw and fed our own industries usefully.

Wages Dispute.

At the time of writing over 100 men employed as vehicle workers by the Gloucester Railway Carriage and Wagon Company, Ld., are out on strike owing to a wages dispute. The men asked that the Birmingham scale of wages for vehicle workers should be paid, and the company maintained that the Gloucester rate was applicable. The workers affected are members of the National Union of Vehicle Builders.

Continued Decrease in Unemployment.

The unemployment returns for the Midlands area show a further decrease of 3073, the present total of 132,904 being, too, 4858 less than it was a fortnight ago. The total is made up as follows :—Men, 93,945 ; boys, 1537 ; women, 34,508 ; girls, 2914. There were approximately 900 less unemployed in the Birmingham area, the figures being :—Men, 18,489 ; women, 7652 ; boys, 197 ; girls, 343 ; total, 26,681. There were 1067 short-time workers on the register. In the Coventry area there was an increase of 15, the number now standing at 1387.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Conditions.

THE markets here for iron and metals are all in a more or less depressed condition, and there is no sign yet of any probable improvement, either in the home or the foreign trade. As to the latter, prospects appear rather more despondent than before. Work which used to be considered British without any question, such as shipbuilding, is going abroad, and one cannot be surprised, when it is realised that from £2 to £3 per ton can be saved on the steel, and an unknown, but very large, sum on the wages. Much more work of this kind will go out of the country unless some drastic measures are taken to reduce the overwhelming burdens under which our industries are staggering to-day. The general feeling in the Manchester markets this week is one of almost unrelieved depression, and that at a time of year when the feeling ought to be most hopeful. One wonders what will be the state of feeling in the stagnant summer months.

Metals.

Very great disappointment is expressed here as to the general condition of the non-ferrous metal markets, and yet there has been no serious change in the position, and not very much disturbance of prices, except

in tin. The latter seems to have got out of the rut, and to be moving up and down more freely; but operators seem to be very undecided as to the future of this metal. The very high premium upon Straits and Banka tin puzzles people a good deal. It seems very far from reasonable to pay £6 and £7 per ton more for Straits tin than for standard, and the position must be considered unnatural. Another "bear" attack on the market is, of course, possible, and the position is too uncertain to allow of any very definite view being taken; but in the absence of aggressive "bear" tactics, the prices appear to be moderate enough. In the copper market one finds very little life, and no disposition on the part of consumers to take advantage of the easier prices. Copper, of course, moves only to a slight extent in a downward direction, as there is scarcely any margin that way. When trade revives, and the manufacturing world is active again, the upward movement in copper may not be slow. The drop in copper prices recently is easily covered by about 30s. per ton, and yet it has produced a depressing effect, out of all proportion to its extent. Probably the reason is that confidence in copper was just beginning to grow, and many people had bought for a rise when the check came. Some of these people were scared, and began to get out without much regard to the realities of the situation. Of course, the root of the trouble in regard to copper is that the actual production capacity of the world is greater than the present rate of consumption; but this rate of consumption will rapidly grow when the world becomes richer. The local market here for copper and the alloys—scrap, gunmetal, &c.—is, of course, affected by the state of work at the engineering establishments. There seems to be a good deal of nervousness about a possible stoppage, and, of course, the consumer does not wish to have money locked up in metals should this come about. In the market for lead there is a good deal of uncertainty here. A further fall is thought probable, but it is said that there is a big "bear" account open in lead, and if this has to be closed, some movement towards higher prices might occur, if only for a time.

Pig Iron.

The market here for foundry iron remains dull and lifeless. Those consumers who have contracts running are now at a very considerable disadvantage, as compared with those who have trusted to chance and are buying the iron they need just as they want it. There is quite a considerable quantity of No. 3 Derbyshire foundry iron yet to come in at 90s. per ton, or very nearly 5s. more than the price at which it could now be bought, and this difference is a serious consideration now that the competition for work at the foundries is so keen. It is a little difficult to believe that foundry iron can fall very much more, but one hesitates to put a limit on the fall by reckoning up the costs of production. If the Cleveland makers should try to get back their old markets in Lancashire, we may see lower prices; but so far one does not observe any disposition on their part to attempt this rather risky adventure. Makers of Derbyshire iron usually base their prices here on 79s. at the furnaces; but there are some makers who have booked at 78s., and most consumers here now expect to buy at the latter price, or at 85s. 6d. per ton delivered in Manchester. For Northamptonshire foundry iron 74s. at the furnaces is still quoted, and at this figure the iron cannot compete with Derbyshire in Manchester; but it may compete in some of the Midland districts. One hears little of Staffordshire pig iron in this district, and in any case it would be rather dearer than Derbyshire. Scotch iron is unchanged at 103s. 6d. to 104s. 6d. per ton delivered, and the demand for it keeps within very narrow limits.

Finished Material.

The position with regard to manufactured iron and steel is no better. The price of the local bar iron stands in the way of any large volume of business, as the force of competition almost compels the users here to have recourse to the cheaper foreign irons. Foreign steel is also rather easier than it was, but, of course, the difference is nothing like what it is in bar iron. Theoretically, joists and angles delivered in Manchester are still at £8 15s., and steel plates at £9 15s.; but it is generally believed that considerable concessions on these prices are available. Foreign joists have been sold at less than £5 10s. f.o.b. Antwerp. There has at last been a weakness in the sheet steel market, and some makers have reduced their prices by 20s. per ton.

Scrap.

Dealers in scrap seem to be very despondent just now. Steel scrap is especially dull, and it is rather difficult to say what the value is here. Probably 62s. 6d. per ton for heavy melting scrap and 52s. 6d. for steel turnings would be near the mark. The demand for wrought scrap is feeble at about 80s. to 85s. per ton delivered. The ironfounders are looking for lower prices for ordinary qualities of cast scrap. With pig iron at about 85s., they claim that they ought to be able to get ordinary scrap at 75s. per ton. Dealers, however, are still trying for 80s. Common cast scrap is plentiful here, but there is not very much special scrap, such as that from textile machinery. Some dealers still quote 87s. 6d. per ton for this, but probably it could be bought at 85s. delivered.

Ball and Roller Bearings.

A paper on "Ball and Roller Bearings" was read before a meeting of the Manchester Association of Engineers on Friday, 13th inst., by Mr. E. Baker, B. Eng., M.C. The author's object was chiefly to focus attention on the fundamentals of pure rolling motion, and he showed how this ideal could be approached in practice. He said the failure of the cup and cone ball bearing resulted in the evolution of the modern ball bearing, many examples of which were illustrated by lantern slides. The modern roller journal bearing, the author said, had been more difficult to achieve than the ball bearing. In order to eliminate skewing of the rollers and the end thrust which that entailed it had been found necessary to limit the length of the rollers to their own diameter, to make them to the same degree of accuracy as that of balls, and to provide adequate guidance for the rollers. It was stated that the geometrical property possessed by the roller bearing in having no groove in the outer race was useful in a number of cases. As the rollers could slide through the outer race both races could be made a tight fit on or in their respective parts. Other advantages of the roller journal were the increased load bearing capacity and ability to withstand greater shock loads than the corresponding ball journal bearing. It had been supposed that the coefficient of friction of the roller bearing would be higher than that of the corresponding ball journal bearing, but experiments carried out at the National Physical Laboratory showed that at low speeds and loads there was very little difference, which at heavy loads the coefficient of friction was 30 per cent. to 40 per cent. less than that of the ball bearing.

BARROW-IN-FURNESS.

Hematite.

The condition of the hematite pig iron trade in the north-western district is about the same as it was last week. The demand has neither lessened nor increased, but the outlook is not of the best. Buyers are still taking only what they immediately require, and are showing no tendency to place orders for forward delivery. There are thirteen furnaces in blast in the district, and a fair quantity of the iron turned out is required for the steel departments in Barrow and at Moss Bay, in Cumberland. If there were to be a lengthy stoppage in the steel trade, there would have to be a curtailment in output. As to whether that will happen in the next month or two depends on many things. At present there are no orders for large tonnage. The Continent is buying very little. A certain amount goes out every month, but the amount is not heavy. America has been a moderate customer, and there may be more business done, but it is very difficult to reckon up the demand, which is spasmodic. The ore trade is in a very similar state to that of pig iron, as it is largely governed by the iron market, in view of the fact that there is not a great deal going out to smelters in other parts of the country. Foreign ores are in moderate demand.

Steel.

The steel trade does not show much difference. Orders are being received, but they are not for large parcels. The rail mills at Moss Bay are employed irregularly. At Barrow the rail mill has enough orders for a few weeks' run. The Siemens departments are at work, as also are the foundries. The small section and hoop mills are better situated for the present.

SHEFFIELD.

(From our own Correspondent.)

The Heavy Steel Trade.

THE depressed condition of affairs, so far as raw material and semi-manufactured steel products are concerned, continues unrelieved, and, as a number of the finished lines are less busy, the general situation has become worse during the week. The closing of the basic steel furnaces in the Rotherham district, which I referred to last week, has caused a large addition to the ranks of the unemployed. The Parkgate Company continues to be able to work up to a large percentage of its capacity. The acid steel side of the trade is better than the basic, and several firms are doing moderately well in this department. The demand for railway supplies accounts for the use of large quantities of acid steel. Some new railway orders are reported this week. They have been secured by Craven's Railway Carriage and Wagon Company, Ld., Darnall, Sheffield, which is to build twelve dining, sleeping and first-class carriages for the Antofagasta and Bolivia Railway, and a saloon for H.M. the King of Siam, for use on the Royal State Railways of that country.

Past Year's Results.

Two dividend announcements have been made during the past few days. In the case of John Baker and Co., Ld., of Rotherham, a firm largely engaged on railway work, the directors are able to recommend a distribution of 7½ per cent., less tax. This is a great improvement on recent years. Last year, only 2½ per cent. was paid, while for the two years before that there was no dividend at all. Cammell Laird and Co., Ld., are not so fortunate. They made a profit during the year which was practically equal to that of 1923, but, for the second year in succession, they are not paying any ordinary dividend. The report states that trade conditions—largely as a result of foreign competition—were depressed, and ruling prices were lower than in 1923.

Various Steel Departments.

The tool trades continue in much the same position as I reported last week, with somewhat of a downward tendency. The Board of Trade returns show an improvement in the export of various kinds of tools, this year's figures, so far, being substantially more than those for the corresponding months of last year. The shipments of farm tools in February were valued at £15,000 more than those of February, 1923. A market which is not often mentioned, but with which a certain amount of trade continues to be done, is Russia. That country requires large quantities of cross-cut saws, files and edge tools, but the trade is severely limited, owing to financial conditions. It affords considerable employment for a few firms, however. German competition is now being felt in cold rolled steel strip, the Sheffield and Birmingham makers of which have been enjoying good trade for several years. The German material does not carry the same high finish as the home product, but it is useful for some purposes, and, as it is being offered at £2 to £3 per ton below British prices, considerable quantities of it are being bought.

Opening Out a Tunnel.

The London, Midland and Scottish Railway Company has in view the widening of a very busy portion of its main line between Leeds and Sheffield. It is to lay two additional sets of metals for a distance of 3¼ miles, from Chevet Junction to Snydale Junction, near Normanton, thus removing an awkward "bottle-neck" at a point where the railway touches one of the central districts of the South Yorkshire coalfield. The widening necessitates the demolition of Chevet tunnel, half a mile south of Sandal and Walton Station, and this work is now being carried out. The tunnel is upwards of 700 yards long, and the rail level is about 94ft. below the surface of the hill through which it passes. The unroofing involves the cutting of a passage through nearly 80ft. of solid sandstone. The number of trains passing through the tunnel is about 240 per day, but the blasting operations are being carried on at intervals during the day and night, with little interference with traffic. In order to prevent any fall of bricks on to the metals, large shields are placed beneath the arched roof. About a third of the tunnel, at the southern end, has been opened out up to the present. The widening of that portion of the line which runs from Chevet Junction to Sandal and Walton Station is being taken in hand first, and is expected to be completed by the end of this year. The contracts for the remaining portion, between Sandal and Walton Station and Snydale Junction, are to be let shortly.

A 95-Ton Casting.

A casting of exceptional size has recently been made by the Brightside Foundry and Engineering Co., Ld., Sheffield, and despatched to a firm in the Leeds district. It was an anvil block, for use with a drop stamp, and weighed no less than 95 tons. It was not specially notable for its weight, as the same firm has on several occasions produced castings of more than 100 tons, but it had a claim to pre-eminence in being the heaviest that it had ever had transported by rail. In order to obtain the necessary metal for the casting, four cupolas and two air furnaces were blowing simultaneously, the cupolas being responsible for 28 tons per hour. The metal was all down in three hours. The casting was "fed" from a stand ladle of 42-ton capacity, a 23-ton ladle and two 17-ton ladles. This operation occupied about 30 hours. The casting was left in the pit for about a fortnight, before being finally lifted out with a 120-ton crane.

New South Yorkshire Colliery.

Preparations for the opening up of another big colliery in South Yorkshire are going on apace. This pit is at Upton, not far from North Elmsall, between Doncaster and Barnsley, and is a joint enterprise of the Cortonwood Collieries, Ld., of Wombwell, and Bolckow, Vaughan and Co., Ld., of Middlesbrough. The first sod was cut twelve months ago, and the intervening time has been devoted to the erection of surface buildings, which have made capital progress. One shaft has been sunk to a depth sufficient to allow of the putting in of concrete foundations for the head gear, which is now being built. The sinking operations will be carried out by means of the permanent winding apparatus. The power-house, which is on a large scale, is nearing completion, and two winding engines, built by Messrs. Markham, of Chesterfield, are being installed. The boiler-house is almost erected, and the boilers are in position. A modern eighteen-chamber brick kiln is being erected, with a capacity of 10 million bricks per annum. The actual sinking operations are to begin shortly, and it is expected that the Barnsley seam, at a depth of about 650 yards, will be reached in eighteen months. The company contemplates working this, and also the Haigh Moor seam, which is 80 yards lower down. It is hoped to have an eventual output of 1¼ million tons a year. At a still greater depth of 200 yards is the Parkgate seam. The Wharncliffe Silkstone Colliery Company reports a successful year. The amount of coal raised in 1924 was 346,896 tons, of which 91,559 tons were carbonised, an increase of 8665 tons raised and 13,240 tons carbonised. At Hadfield Main the output has reached over 8000 tons weekly, and is gradually increasing. The year's working, states the report, shows a loss of £65,397, which is again due to expenses in connection with the faults mentioned last year, and to delay in the erection of cottages caused by a strike in the building trade. The company has now 683 cottages built and occupied, 297 in course of erection, and contracts let for 191 more.

Cutlery and Plate.

After enjoying much activity for a considerable time, the cutlery trade has suffered a serious setback, and the conditions now prevailing are among the quietest that have been known for several years. Even stainless knives are affected. The large firms are feeling the change acutely, and some of the small manufacturers, who quote very cut prices, are finding orders difficult to get. The pen and pocket-knife departments have lately experienced an improvement, but some of the principal makers have now had to put their workpeople on short time. In the electro-plate trade, the demand for good-class hollow-ware is still on a very small scale, and the output of spoons and forks, though it continues large, has fallen off somewhat.

Thirty New Trawlers.

An important scheme of trawler building has been adopted by six or eight of the leading fishing firms of Hull, which are to augment their fleets by thirty large modern trawlers, at a total cost of £500,000. Eight of these vessels are being built by Messrs. Cochranes, of Selby, at a cost of £15,000 or £16,000 each; Cook, Welton and Gemmell, Ld., of Beverley, are building nine, and the shipyards at Hull itself are all enjoying greater activity than they have known for some time. It is expected that the first of the trawlers will be ready by August, and that the others will follow at intervals until December, so that all will be delivered in time for the winter fishing season.

NORTH OF ENGLAND.

(From our own Correspondent.)

Pit to Remain Idle.

THE miners of Hazlerigg Colliery, near Newcastle, have declined to accept a scheme proposed by the management for the working of the pit during the present crisis. The immediate effect is that 1400 employees of the company remain idle, and the ultimate result might be the permanent closing of the colliery. The Hazlerigg Colliery was stopped on February 14th, after losses amounting to about £1000 per fortnight had been incurred for nine months. Three weeks afterwards the management was asked by the men to meet them to consider what could be done and what help could be given to them. It was explained to the miners that the position of the company was a very serious one, and that nothing could be done in the way suggested, but a scheme to get the colliery restarted was submitted to them for approval. The management pointed out that under the proposed scheme a loss of at least 2s. per ton would be incurred; but as that was about the same amount as it cost to maintain the pit when idle, and as the proposal was one which would enable the majority of the men to get back to work, it was thought that it should accept it. The scheme was to work one seam of coal at the colliery on the three-shift system, and the management stated that it knew the men's objections to that course: but it put the proposal forward as a temporary measure to get the colliery restarted. There was no alternative. One of the members of the deputation who waited upon the management was shown the books of the company so that he might see for himself that the losses were actual. The miners took several days to consider the matter, and on Tuesday their decision was conveyed to the management. It was that they had unanimously decided not to accept the scheme as it was unconstitutional.

Cleveland Iron Trade.

The Cleveland pig iron trade displays no improvement and prices show an all-round decline of 6d. per ton on the week. Still, though the market is admittedly weak, Cleveland iron prices are now getting down to a competitive level, and it ought to be possible to book foreign orders at or near current rates. The trouble is that the continental demand for iron is so limited and credits so difficult to arrange, that the possible volume of the export trade is very limited. Moreover, with prices steadily sagging, home consumers are disinclined to buy. Few of the engineering works and foundries are busy; they are using less iron than normally, and until prices have become steadier are content to buy from hand to mouth. There is, too, a reluctance in some directions to take out iron bought two or three months ago at a much higher price than is now quoted. This all makes for weakness; but in spite of all, the amount of foundry iron on makers' hands is not large, and any accession of demand would immediately firm up prices. Meanwhile, No. 3 Cleveland G.M.B. is down to 77s. 6d. per ton, and No. 1 is 82s. 6d., No. 4 foundry 76s. 6d., and No. 4 forge 75s. 6d. per ton.

East Coast Hematite.

The East Coast hematite makers are now saddled with heavy stocks, which, notwithstanding price concessions, tend to increase. There have been sales at very low figures, but in this district makers now quote 84s. 6d. per ton for mixed numbers, though it is well understood that 84s. would not be refused for an order of any size. No. 1 is 6d. per ton more than mixed numbers.

Ironmaking Materials.

Despite the absence of business foreign ore continues steady, and nothing less than 22s. per ton is named for best Rubio ore c.i.f. Tees. Coke prices are irregular, but good Durham furnace brands are on offer at 23s. per ton and might even be bought at a little less.

Manufactured Iron and Steel.

The depression in the manufactured iron and steel trade is entirely unrelieved, and manufacturers are having considerable difficulty in keeping their plant in operation. Nominally quotations are unaltered, but they can be cut, and f.o.b. export prices are well below home quotations.

The Coal Trade.

The position in the Northern coal trade is very discouraging and without any signs of an increased demand setting in. The output, although of recent restricted dimensions, is still in excess of prompt requirements, and to clear spot lots further discounts have been made; but, on the whole, the prices quoted for the remainder of this month and for April are on the basis of last week's figures. The prospects are very disappointing, and no great expectation of a revival in the demand for early spring shipment is held. Fitters are having a hard struggle to carry on, although the majority of the pits working are entailing heavy money losses to the owners. The demand for coke is quiet, and buyers hold off the market, except for small hand-to-mouth parcels, and values are difficult to maintain.

SCOTLAND.

(From our own Correspondent.)

Idle Conditions.

ANOTHER week has come and gone without bringing any sign of the much longed for improvement in industrial circles generally. Stagnation is apparent on all hands, and with the year advancing there seems little hope of any substantial change until after the summer, if even then. Up till now home makers have found it impossible to combat foreign prices in overseas markets, and the loss of business has been a severe blow. Furthermore, the inflow of foreign goods has crippled the home market until the tone has become extremely dull and proceedings apathetic. Again, the uncertainties with regard to the labour attitude remain. The determination to insist on shorter working days cannot be regarded otherwise than suicidal, in the light of working conditions in competitive countries. The right to conduct sectional strikes, involving, as it must inevitably do, many other departments, is only a bugbear, and a menace to continuous industrial activity for any lengthy period. The present-day tendency to strike for better terms immediately there are signs of the slightest increase in trade has undoubtedly helped to influence makers towards an ultra-cautious attitude in respect to lengthy contracts which might at any period be rendered unprofitable, if not entirely a dead loss. There is little doubt that until some more stable basis of communication is set up between maker and worker, there will be small hope of any lasting improvement in business, even although a moderate revival in trade should soon materialise.

Pig Iron.

The demand for all grades of pig iron leaves much to be desired. Steel and iron makers are poor buyers at present, while export is of such small dimensions that this class of business may be termed non-existent. The production has already been practically reduced to the minimum, and any further movement would mean an almost entire cessation of output. Meantime stocks in makers' yards increase, while prices weaken.

Steel.

With the exception of steel sheets of light gauge, and to a much lesser degree heavy sheets, there is almost no movement in steel of any note. Black sheets have plenty of orders, but galvanised varieties are the particularly bright spot. Plates are poorly bought, and makers have extreme difficulty in securing specifications for even a few days ahead. Sectional material is really no better off than plates. Prices are all unchanged. Scrap material is a weak market at present, the demand being unusually short.

Bar Iron.

The bar iron trade fails to show any improvement, and the majority of the mills are moving slowly. Home demands are very intermittent, and export orders are few and small in bulk. A slight improvement is noticeable in the re-rolled steel department, a moderate turnover having been done between £9 10s. to £9 15s. per ton.

Coal.

So far as the coal trade is concerned, there has been absolutely no indication of any improvement in general conditions. The volume of business all over is extremely disappointing, and even with reduced outputs the supplies available are not in any way taxed. In the export department few prompt orders are negotiated, even at what may be termed sacrificial prices, while forward business is well-nigh impossible. With the exception of prime Lanarkshire splints, all descriptions of fuel continue to weaken, and treble and double nuts are especially in need of new business. The collieries in the east of Scotland are feeling the strain to an even greater extent than those in the west, owing to the lack of export orders, which in normal times absorb large quantities. Aggregate shipments amounted to 207,792 tons, against 220,502 tons in the preceding week and 296,005 tons in the same week last year. The home market also is dull. Apart from best household fuel, there is no firm demand. Industrial requirements continue far below normal, and gas and electricity works are beginning to slacken off.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

DEPRESSING conditions have been the main feature of the steam coal trade during the past week. Certainly there has been no improvement in the general demand for current shipment, while no fresh inquiry of note for supplies over a period has been received on the market, which, as a consequence, is dull. News comes to hand almost daily of fresh penetration into markets by German coals, which is a very disturbing factor, seeing that the prices at which foreign coals are offered are in most cases several shillings below what local exporters can possibly accept, in view of the figures demanded by South Wales producers. It is questionable whether the industry has ever passed through a greater period of depression than exists at the present time, and unfortunately until costs of production of coals in this district can be substantially reduced there seems to be very little prospect for the future. Most of the collieries are working very irregularly, which in itself is an expensive matter, and as homeward business is in a stagnant condition, this means that outward freights are tending to higher figures, which adds to the difficulties of firms quoting on a c.i.f. basis, and, furthermore, there is the fact that the foreign exchanges are anything but favourable to the completion of business with continental consumers. At the end of last week there were over thirty tipping appliances idle at the various South Wales docks, and tonnage arrivals over last week-end were below expectations, with the result that on Monday last there were as many as twenty-three loading berths unoccupied. In these circumstances, the free shipment of coals was hampered, and standing stocks of coal remain very heavy, while the supply of empty wagons continues to be short and operates against pits working continuously.

Miners' Experiment.

Considerable interest is being displayed in the experiment now being carried on at the Vauxhall Colliery, Ruabon, where the miners have agreed to cover the owners against loss for three months, thus enabling work to be continued at this colliery. Owing to the fact that the colliery was not paying, the owners served notices upon the workmen, numbering about 700, and these notices terminated on the 10th inst. Negotiations, however, took place between the workmen and the owners, without the aid or support of the Federation officials, with a view to enabling operations to continue. At least 400 of the workmen are elderly, and if the pit had been closed it was felt that they would have stood very little chance of obtaining employment elsewhere. In addition to agreeing to share the losses with the owners, the men have accepted a revised price list, but the rates to be paid are the same as those for similar seams at the other pits in that district. The men will work the usual hours, and will in no way contravene the Seven Hours Act or the Coal Mines Regulations. The sum of £400 has been banked at Wrexham to form part of the guarantee fund to cover any losses the owners may sustain during the next three months. This has been subscribed by the royalty owners, the workmen, colliers at other pits, tradesmen, co-operative societies and the general public. The experiment is being watched very closely by the Miners' Federation, and with none too favourable an attitude, so far as some of the officials are concerned, and it is reported that a motion is to be brought forward at the next meeting of the Federation to expel the Vauxhall men from the Association.

A New Project.

Following upon the success of the plant at the Willesden works of the British Oil and Fuel Conservation, Ld., it is reported that a new company is to install two retorts at the head of two pits near to Cardiff for the low-temperture carbonisation of coal. It is understood that certain South Wales coalowners are interested in the project, and it is the aim of the promoters to build up a system of retorts at pitheads in South Wales, so as to make it commercially possible to erect refineries to refine the crude oil extracted from coal into motor spirit, lighting oils, &c. Out of a ton of coal suitable for the process, after treatment at the retorts there remains 15 cwt. of good smokeless fuel, which, while retaining its heating properties, has yielded valuable by-products which have hitherto escaped in smoke.

Pooling Scheme.

As the result of a special meeting of the Joint Committee held last week, it was decided to continue the stabilisation of prices scheme in the South Wales steel and tin-plate industries until October next, but before that time the Committee will again meet to review the position. It is only a few months ago that the decision was come to definitely to continue the arrangement for a period of twelve months. In view of the state of the tin-plate trade, it has also been agreed to adopt a pooling arrangement, by which orders will be divided up *pro rata* per mill, and therefore employment for the workmen will be levelled up. Although the conditions of trade continue to be quiet, it is reported that the outlook is a little brighter.

G.W.R. Concession.

Since the whole of the docks in this district came under the control of the Great Western Railway Company, one of the grievances of shipowners has been that they have been unable to transfer their ships from one port to another without incurring the cost of double dues. The Great Western Company has now, however, taken steps to meet the position, and as from Monday next it has been decided that only one tonnage rate will be charged in respect of vessels changing docks within the Customs port of Cardiff, viz., Cardiff, Penarth and Barry. There will be an extra locking fee, which is based on a scale according to the net register of the vessels. Owners regret that the concession only applies to the port of Cardiff, and no doubt they will continue their efforts to obtain the facility for steamers moving from one dock to another between the ports of Newport and Swansea inclusive.

Current Business.

Operations on the steam coal market continue to be very quiet, and values of all descriptions are very uneven, especially for prompt shipment. The demand is far below what is required to give a steady tone to the market. Prices are for the most part without change, but they are to a large extent nominal, and collieries are prepared to make concessions to those buyers who are able to take quick delivery of standing coals. Best Admiralty large are round about 26s. to 26s. 9d., and second qualities are quoted at 25s. to 26s. Small coals have a steadier appearance, as supplies are not so plentiful, owing to the slack working at the pits. Patent fuel and coke move off slowly. The conditions in the anthracite trade are rather quiet for immediate shipment, but are likely to improve shortly when shipments commence on an active scale for Canada next month.

Latest News from the Provinces.

WALES AND ADJOINING COUNTIES.

Colliery Deal.

THE report is current that negotiations are in progress and are nearing completion between the Powell Duffryn Steam Coal Company, Ld., and Guest, Keen and Nettlefolds, Ld., for the acquisition by the former of the colliery undertakings in the Dowlais and Fochriw area, owned by the latter. Nothing official however, is so far obtainable.

THE position of superintendent of signals and telegraphs on the Metropolitan Railway, vacant by the transfer of Mr. W. A. Challis to the Southern Railway as assistant signal and telegraph superintendent, has been filled by the appointment of Major R. Falshaw Morkill

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	17/6 to 24/-
(1) Spanish	21/-
(1) N. African	21/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	22/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	4 11 6	—
No. 1 Foundry	4 11 6	—
No. 3 Foundry	4 9 0	—
N.E. Coast—		
Hematite Mixed Nos.	4 4 6	4 4 6
No. 1	4 5 0	4 5 0
Cleveland—		
No. 1	4 2 6	4 2 6
Silicious Iron	4 3 0	4 3 0
No. 3 G.M.B.	3 17 6	3 17 6
No. 4 Foundry	3 16 6	3 16 6
No. 4 Forge	3 15 6	3 15 6
Mottled	—	—
White	—	—
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 12 6 to 3 14 0	
,, Forge	3 8 0 to 3 9 0	
(3) Derbyshire—		
No. 3 Foundry	3 17 6 to 3 19 0	
Forge	3 15 0	—
(3) Lincolnshire—		
No. 3 Foundry	4 2 6	—
No. 4 Forge	3 17 6	—
Basic	4 0 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	5 0 0 (a), 5 2 6 (b), 5 5 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	12 0 0	—
Best ,,	—	—
N.E. Coast—		
Common Bars	12 0 0	—
Lancs.—		
Crown Bars	13 0 0	—
Second Quality Bars	12 0 0	—
Hoops	15 0 0	14 15 0
S. Yorks.—		
Crown Bars	13 0 0	—
Best ,,	13 10 0	—
Hoops	14 10 0	—
Midlands—		
Crown Bars	12 15 0	—
Marked Bars (Staffs.)	15 0 0	—
Nut and Bolt Bars	11 15 0	—
Gas Tube Strip	13 0 0 to 13 2 6	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	13 0 0	—
Ship Plates, ¾in. and up	9 15 0	—
Sections	9 10 0	—
Steel Sheets, 3/16in. to ¼in.	11 0 0	—
Sheets (Gal. Cor. 24 B.G.)	—	£17 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	9 5 0	—
Angles	9 0 0	—
Boiler Plates	13 0 0	—
Joists	9 0 0	—
Heavy Rails	9 10 0	—
Fish-plates	13 10 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	9 10 0	—
Soft Billets	8 10 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 15 0†	—
Light ,,	9 0 0 to 9 5 0	
Billets	8 0 0 to 11 0 0†	
Manchester—		
Bars (Round)	9 15 0 to 10 0 0	
,, (others)	9 10 0 to 9 15 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	13 15 0	13 10 0
Plates	9 10 0 to 9 15 0	
,, (Lancs. Boiler)	13 0 0	—
Sheffield—		
Siemens Acid Billets	11 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	9 10 0	—
Intermediate Basic	9 0 0	—
Soft Basic	8 0 0 to 8 5 0	
Hoops	12 0 0	—
Soft Wire Rods	11 0 0 to 11 10 0	
Midlands—		
Small Rolled Bars	8 15 0 to 9 15 0	
Billets and Sheet-bars	7 0 0 to 7 10 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	16 5 0 to 16 10 0	
Angles	9 5 0	—
Joists	9 5 0	—
Tees	10 5 0	—
Bridge and Tank Plates	9 15 0	—
Boiler Plates	13 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	22/1½ to 22/6
Block Tin (cash)	241 5 0
,, (three months)	245 0 0
Copper (cash)	62 17 6
,, (three months)	64 0 0
Spanish Lead (cash)	37 5 0
,, (three months)	35 17 6
Spelter (cash)	35 6 3
,, (three months)	34 12 6
Manchester—	
Copper, Best Selected Ingots	68 0 0
,, Electrolytic	69 0 0
,, Strong Sheets	94 0 0
,, Tubes (Basis Price)	‡ 0 1 1½
Brass Tubes (Basis price)	‡ 0 1 0½
,, Condenser	‡ 0 1 2½
Lead, English	39 15 0
,, Foreign	38 5 0

‡ A fall is expected during the week.

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/9 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 0 0	8/-
,, 6 p.c. to 8 p.c. ,,	£23 10 0	7/9
,, 8 p.c. to 10 p.c. ,,	£23 0 0	7/6
,, Specially Refined		
,, Max. 2 p.c. carbon	£42 10 0	16/-
,, ,, 1 p.c. ,,	£32 0 0	17/-
,, ,, 0.75 p.c. carbon	£58 0 0	19/-
,, ,, carbon free	1/5 per lb.	
Metallic Chromium	4/- per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 10 0 scale 5/- per unit	
,, ,, 75 p.c.	£20 5 0 scale 6/- per unit	
,, Vanadium	17/- per lb.	
,, Molybdenum	7/3 per lb.	
,, Titanium (carbon free)	1/- per lb.	
Nickel (per ton)	£175	
Cobalt	10/3 per lb.	
Aluminium (per ton)	£130	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	16/-
,, ,, Ell	18/-
,, ,, Splint	19/- to 22/-
,, ,, Trebles	15/9
,, ,, Doubles	14/6
,, ,, Singles	13/9
Ayrshire—	
(f.o.b. Ports)—Steam	16/-
,, ,, Splints	19/-
,, ,, Trebles	15/9
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	14/4½ to 16/9
Screened Navigation	23/-
Trebles	15/3
Doubles	14/9
Singles	13/9
Lothians—	
(f.o.b. Leith)—Best Steam	15/7½
Secondary Steam	15/-
Trebles	15/-
Doubles	14/4½
Singles	13/6

ENGLAND.

(8) N.W. Coast—	
Steams	28/-
Household	45/- to 58/4
Coke	30/-
Northumberland—	
Best Steams	17/6 to 18/6
Second Steams	17/- to 17/6
Steam Smalls	10/9
Unscreened	15/6 to 16/6
Household	23/6 to 25/-
Durham—	
Best Gas	19/6 to 20/-
Second	17/- to 17/6
Household	23/6 to 25/-
Foundry Coke	22/- to 23/-

Sheffield—	Inland.	
Best Hand-picked Branch	30/- to 33/-	—
Barnsley Best Silkstone	26/- to 28/-	—
Derbyshire Best Brights	26/- to 31/-	—
,, ,, House	24/- to 26/-	—
,, ,, Large Nuts	20/- to 24/-	—
,, ,, Small	14/- to 16/-	—
Yorkshire Hards	18/- to 22/-	—
Derbyshire ,,	18/6 to 22/-	—
Rough Slacks	10/- to 12/6	—
Nutty ,,	8/6 to 10/-	—
Smalls	4/- to 6/6	—
Blast-furnace Coke (Inland)*	—	—
,, ,, (Export)	f.o.b.	20/9 to 21/9

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	26/- to 27/-
Second ,,	25/- to 26/-
Best Dry Large	25/- to 25/6
Ordinary Dry Large	23/6 to 24/6
Best Black Vein Large	24/- to 24/6
Western Valley ,,	23/- to 24/-
Best Eastern Valley Large	23/- to 24/-
Ordinary ,, ,,	22/6 to 23/-
Best Steam Smalls	15/- to 16/-
Ordinary ,,	13/- to 15/-
Washed Nuts	22/- to 28/-
No. 3 Rhondda Large	27/- to 27/6
,, ,, Smalls	17/- to 18/-
No. 2 ,, Large	22/- to 22/6
,, ,, Through	18/- to 20/-
,, ,, Smalls	11/- to 13/-
Foundry Coke (export)	40/- to 47/6
Furnace Coke (export)	25/- to 30/-
Patent Fuel	23/- to 26/6
Pitwood (ex ship)	23/- to 24/-
Swansea—	
Anthracite Coals:	
Best Big Vein Large	40/- to 42/6
Seconds	32/6 to 35/-
Red Vein	29/- to 32/-
Machine-made Cobbles	45/- to 50/-
Nuts	50/- to 52/6
Beans	44/- to 45/-
Peas	20/- to 23/6
Breaker Duff	9/- to 9/6
Rubbly Culm	9/3 to 9/9
Steam Coals:	
Large	22/- to 24/-
Seconds	21/- to 22/-
Smalls	10/- to 13/-
Cargo Through	16/- to 19/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 16/9, with fluctuations according to analysis open market, 18/- to 19/- at ovens. † Latest quotations available. (a) Delivered Glasgow, (b) Delivered Sheffield. (c) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Home and Export Prices.

THE putting up of prices of pig iron, blooms and billets and other material at a time when there is a heavy surplus production and a diminishing demand is arousing protests from consumers, who are endeavouring to organise themselves with a view of taking the necessary action to protect their interests. The possible output of raw and semi-manufactured material will always far exceed the home needs, and in view of the accumulation of stocks and the falling prices producers have succeeded in creating a syndicate for the maintenance of prices on the French market. That body has only taken definite form after long negotiation, and it is not yet complete, but its operations have already had the effect of causing a steady rise in prices. A further increase is announced for the first of next month. The advance is naturally extending to rolled iron and steel, and all kinds of material have consequently become dearer at a time when the consumption is below the normal. Consumers of pig iron and blooms and billets are protesting that it is unfair to make them pay artificially inflated prices in order to allow producers to dispose of their material at lower rates in foreign markets. The system pursued by producers is nothing but "dumping" in disguise. It is a serious check to business activity, when iron and steel consumers find themselves in a somewhat precarious situation through the restrictions and burdens which recent legislation has sought to impose upon industry. Except in building there is a decline in activity everywhere, and buyers are holding their hands until they can see what the early future will bring forth. The presidents of the Chambers of Commerce throughout the country have met and passed a series of resolutions solemnly warning the Government against the consequences of its repeated attempts to impose additional charges upon industry. They tend necessarily to increase manufacturing costs, and if to these burdens be added higher prices for raw material to enable producers to dispose of their surplus output on foreign markets, iron and steel consumers are themselves placed in a less satisfactory position to compete for foreign trade. So far, the advancing prices of iron and steel have had no effect in stimulating demand.

Suction Gas Vehicles.

The Paris-Orleans Railway Company has for some years past shown considerable enterprise in organising demonstrations of various apparatus of interest to the agricultural and industrial regions served by the railway system, and it has now arranged to hold a congress, under the patronage of the Minister of Agriculture, devoted to questions relating to the application of charcoal suction gas producers to motor vehicles. The congress will take place at Blois on April 24th, when demonstrations will be made of apparatus for carbonising and distilling wood, and vehicles utilising charcoal suction gas plants and spirit distilled from wood will run on three circuits around Blois. The problem at the moment is to insure ample supplies of cheap charcoal, the price of which has been steadily increasing with the growing demand, by introducing portable apparatus for carbonising small wood and brushwood that has at present little value and can be procured in almost unlimited quantities. The necessity of ensuring regular supplies is one of the reasons why the Government has decided to devote a considerable sum of money to afforestation, which is also intended to assist in reducing the liability to floods that are believed to have been occasioned largely by the wholesale destruction of forests.

Motor Cars.

The motor car industry is particularly affected by the general feeling of uncertainty which is inducing customers to delay purchases, and those firms which have been relying upon contracts with agents find that they are reluctant to take deliveries. A certain number of factories are working full time, but those which laid themselves out for the mass production of popular cars have been obliged to slow down, and it is evident that makers will have to rely more and more upon foreign markets for the disposal of an increasing surplus output. The production of light cars is likely to grow considerably in the early future if there be any truth in the statement that Mr. Ford is negotiating for the purchase of a factory in the Paris suburbs, which will supplement the production of the works at Bordeaux where the vehicles are mainly erected with imported parts. The purchase of the Léon Bollée factory at Le Mans by Mr. Morris has now been completed, and will provide before long a further appreciable addition to the production of light touring cars.

Ethylic Alcohol.

At a recent meeting of the Société de Chimie Industrielle it was stated that the Béthune Colliery Company will soon be in a position to produce alcohol from coke oven gases on an industrial scale. From 13 to 19 kilos. of alcohol are obtained from the carbonisation of a ton of coal.

Patent Legislation.

The new Bill which has been prepared for a reform of the patent legislation provides for a preliminary examination in cases in which it is required. At present there is no examination, and an inventor can make any claims he pleases which are invariably granted, and his only protection lies in the Law Courts which require absolute proof of anticipation before a patent is declared void. On the whole, the system is regarded as having advantages, in the sense that the inventor's claims are not narrowed down to a rigid specification. Considerable discussion is, therefore, taking place on the new Bill which, as a transitory measure, gives the inventor the choice of subjecting his claims to examination or not, and, if it be found eventually that the examination is required generally, it will become compulsory.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

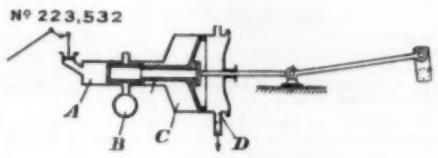
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM ENGINES.

223,532. June 2nd, 1924.—UNIFLOW ENGINES, Sulzer Frères Société Anonyme, Winterthür, Switzerland.

In this uniflow engine a compounding system is adopted, the steam being first expanded in the high-pressure cylinder A and

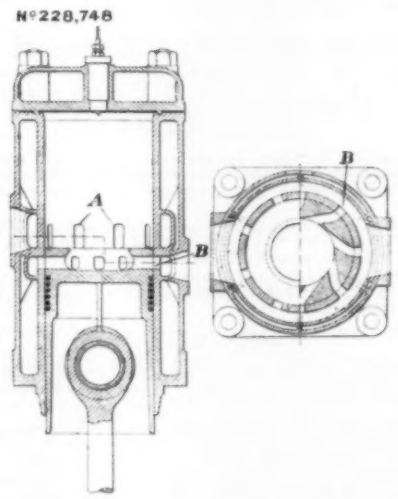


passing, by way of the receiver B, to the low-pressure cylinder C, whence it is exhausted at D. The specification includes several modifications, one of which is of the triple-expansion type.—*February 12th*, 1925.

INTERNAL COMBUSTION ENGINES.

228,748. April 15th, 1924.—TWO-STROKE ENGINES, W. H. Allen, Sons and Co., Ld., Bedford, B. W. Knott, and T. Smith.

In this engine the exhaust ports A are arranged immediately above the transfer ports B, and the piston is ported and cham-

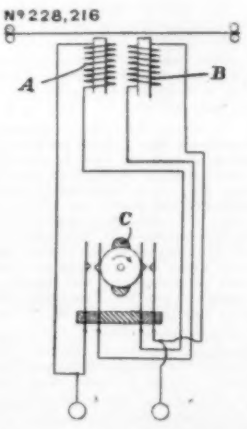


bered, as shown in the drawings, so that when the ports in the piston register with the transfer ports at the end of the stroke the scavenging air comes into the cylinder as a whirling column, and effectively drives out the products of combustion produced during the previous stroke.—*February 12th*, 1925.

TELEGRAPHS AND TELEPHONES.

228,216. August 29th, 1923.—IMPROVEMENTS IN OR RELATING TO TELEPHONE RECEIVERS, Edward Alfred Graham, of St. Andrew's Works, Crofton Park, Brockley.

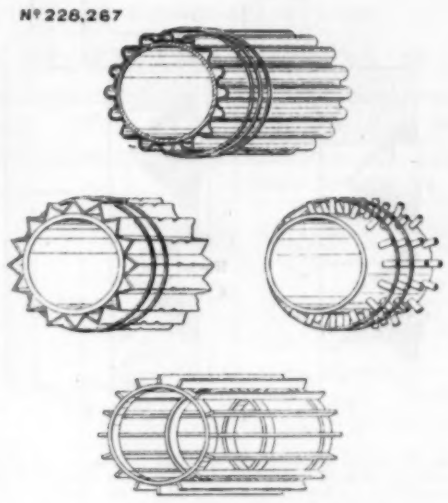
When using wireless valve receivers it is necessary, in order to obtain the best results, that the telephone receiver should be adapted to suit the last valve in the set. When using a low-



power valve which has a high impedance, the telephone should also have a high impedance, whilst when using a high-power valve which has a relatively low impedance, the telephone should also have a relatively low impedance. According to this invention the two windings A and B of the telephone receiver can be connected in series or parallel by means of a switch C, so that the total resistance of the receiver can be altered to suit the valve employed. Another scheme which gives total resistances of 2000, 500, and 125 ohms is described.—*January 29th*, 1925.

228,267. November 1st, 1923.—IMPROVEMENTS IN ELECTRIC INDUCTANCE COILS AND IN FORMERS THEREOF, Ernest Charles Washington.

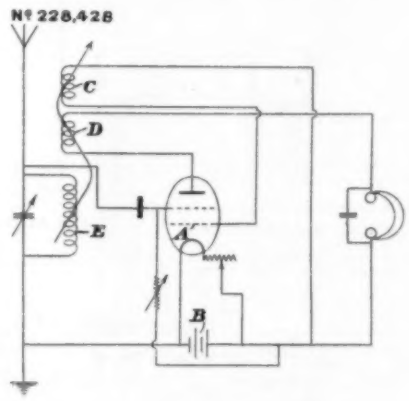
The object of this invention is to reduce the self capacity of coils that carry radio frequency currents. Several alternative schemes are shown in the drawings, which are self-explanatory.



It will be seen that each turn only touches the former at a few points. The dielectric is therefore mainly air and the self capacity of the coil is reduced to a low value. Two other arrangements are shown in the specification and the method of making the formers is described.—*February 2nd*, 1925.

228,428. January 27th, 1924.—A FOUR-ELECTRODE VALVE CIRCUIT, Rodo Patents, Limited, of 15, Grape-street, W.C. 2; and Frederick Arnold Louis Sloot, of 5, Dulverton Mansions, Gray's Inn-road, W.C. 2.

As the diagram shows, this invention relates to a four-electrode valve circuit which operates without a high-tension battery. It is scarcely necessary to describe the circuit in detail, as the main connections will be understood from the diagram. It will

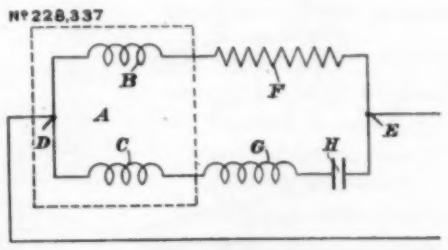


be seen that instead of the inner grid A being connected directly to the positive pole of the battery B, it is connected to this pole through an additional reaction coil C, which is inductively coupled to the main reaction coil D or with the aerial coil E or with both. By these means, the inventors claim, the signal strength is enhanced.—*February 5th*, 1925.

MEASURING AND TESTING INSTRUMENTS.

228,337. January 26th, 1924.—IMPROVEMENTS RELATING TO FREQUENCY METERS FOR ELECTRIC CURRENTS, George Arthur Cheetham, of Homewith, Westmorland-road, Urmston, Manchester; and the Metropolitan-Vickers Electrical Company, Limited, 4, Central Buildings, Westminster.

The frequency meter A is of the well-known type, comprising a shaped disc not shown on the drawings which is mounted on a spindle with an indicating pointer and arranged to be acted upon inductively by two electro-magnets, the operating coils of which are shown at B and C. The coils are arranged in parallel between



the terminals D and E of the meter, which is connected across the circuit the frequency of which is to be measured. A non-inductive resistance F is included in series with the electro-magnet coil B and an inductance G in series with the electro-magnet coil C. A condenser H is also connected in series with the inductance G. The capacity of this condenser is preferably arranged to be such that, together with the inductance G, it provides a circuit substantially resonant at the standard frequency for which the meter is arranged to be used.—*February 5th*, 1925.

228,486. November 14th, 1924.—Water Gauges, R. von Kalmann, 13, Jagerhofstrasse, Dusseldorf, Germany.

In this water gauge the level is viewed through a series of glass stoppers A A fixed in the body of the gauge. The thickness of the stopper must be limited, in order to make the water visible,

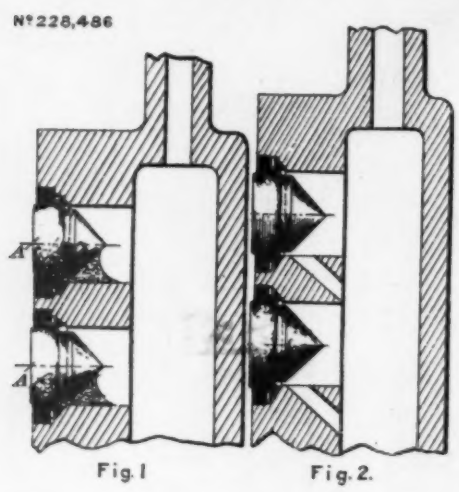


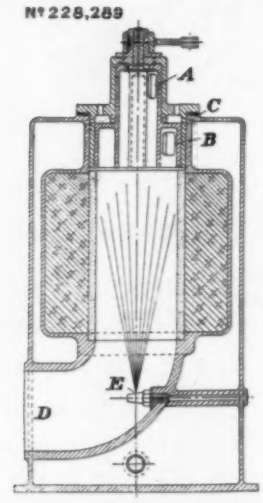
Fig. 1 Fig. 2.

and the stopper consequently lies within the recess. As shown in Fig. 1, there is a liability for water to be trapped in the recess when the level falls, and to deceive the observer. The inventor therefore provides passages, as indicated in Fig. 2, to drain away this water.—*February 5th*, 1925.

GAS PRODUCERS.

228,289. November 16th, 1923.—Gas Generators, F. Umpleby, 24, Tufton-street, Silsden, Yorks.

The inventor proposes to gasify powdered solid fuel by means of the heat generated by its partial combustion. The combustion chamber, it will be seen, is well lagged and is surrounded by a water jacket. The powdered fuel is admitted at A and the air

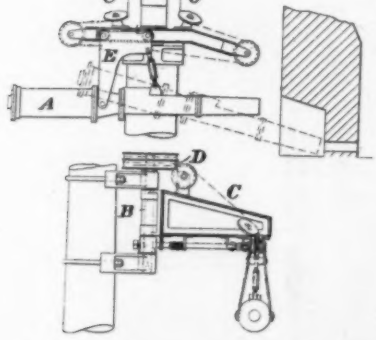


necessary for its partial combustion at B, while steam from the jacket finds access through the passages C. All these openings are adjustable. The resulting gas is delivered at D and, if desired, liquid fuel can be added by the spray E. The inventor suggests the addition of calcareous materials to the fuel in order to produce a catalytic action.—*February 5th*, 1925.

MACHINE TOOLS AND SHOP APPLIANCES.

228,454. August 13th, 1924.—Plugging Furnace Tap Holes, J. M. Ringquist and Head, Wrightson and Co., Limited, Teesdale Ironworks, Thornaby-on-Tees.

This mechanism might be described as an aiming gear for the



clay guns sometimes used for plugging the tapping holes of blast-furnaces, and is intended to bring the muzzle of the gun into position in a single operation. The gun A is mounted on a bracket which swivels on a shaft B attached to one of the furnace columns. A wire rope C C passes round the drum D, and the guide pulleys shown, and is attached to the carriage E which supports the gun. When the drum D is rotated by any convenient means the bracket is first swung round into the working position as the carriage E is locked, but when it is in the proper position the lock is automatically released and the carriage is then pulled forward along its tracks so that it comes into the position indicated by the dotted lines. When the stopping is completed the reverse action is effected.—*February 5th*, 1925.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office an, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institution of Civil Engineers: Birmingham and District Association.—Grand Hotel, Birmingham. Students' joint meeting with the local Student Associations of the Institutions of Electrical and Mechanical Engineers. Discussion on "Modern Road Problems." 7 p.m.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Second Report of the Marine Oil Engine Trials Committee. 6 p.m.

Institution of Mechanical Engineers: Yorkshire Branch.—Brown-Firth Research Laboratories, Sheffield. Paper, "Steel Construction as Applied to Steel Works and Mill Buildings," by Mr. A. A. Fordham. 7.30 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Paper, "Modern Transport," by Mr. S. H. Hole. 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders: Middlesbrough Graduate Section.—Cleveland Scientific and Technical Institution, Middlesbrough. Paper, "The Capital Ship as Affected by the Washington Conference," by Mr. F. H. Todd. 7.30 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1. Discourse, "Soaps and the Theory of Colloids," by Professor J. W. McBain. 9 p.m.

TO-DAY AND TILL SATURDAY, APRIL 4TH.

Marine and Small Craft Exhibition and Congress.—Royal Agricultural Hall, Islington, London, N. 1. 11 a.m. each day.

SATURDAY, MARCH 21ST.

Institute of British Foundrymen: Lancashire Branch, Junior Section.—College of Technology, Manchester. Lecture, "Plate Moulding and the Patternmaker," by Mr. H. Stead, 7 p.m.

Junior Institution of Engineers: North Kent Section.—Staff Dining Hall of J. and E. Hall, Ld., Dartford. Engineering Exhibition. 11 a.m.

Royal Institution of Great Britain, 21, Albemarle-street, London, W. 1. "The Counting of the Atoms—IV., by Sir Ernest Rutherford. 3 p.m.

TUESDAY, MARCH 24TH.

Industrial League and Council.—The Polytechnic, Regent-street, London, W. 1. Lecture, "Payment and Incentives in Industry," by Miss C. Haslett. 6.30 p.m.

Institution of Automobile Engineers.—Broadgate Café, Coventry. Coventry Graduates' meeting. Paper, "Automobile Steels and Irons," by Mr. C. Walker. 7.15 p.m.

Institution of Civil Engineers.—Great George-street, Westminster, London, S.W. 1. Paper, "The Large Water-tube Boiler," by Mr. P. W. Robson. 6 p.m.

Institution of Electrical Engineers: North Midland Centre.—Hotel Metropole, King-street, Leeds. Paper, "Design of Electrical Plant, Control Gear and Connections for Protection against Shock, Fire, and Faults," by Mr. H. W. Clothier 7 p.m.

Institution of Engineers and Shipbuilders in Scotland.—39, Elmbank-crescent, Glasgow. Discussion on "Internal Combustion Turbines," by Professor W. J. Goudie; and "The Manufacture of Brass Condenser Tubes, with some Notes on an Alternative Alloy," by Messrs. G. H. Whiteman and A. Spittle. 7.30 p.m.

Institution of Municipal and County Engineers.—Ye Olde Castle Restaurant, Castle-place, Belfast. Irish District meeting. 1 p.m.

WEDNESDAY, MARCH 25TH.

Institution of Automobile Engineers.—Birmingham Graduates' visit to the works of Morris Commercial Motors, Limited, Soho, Birmingham. 2.30 p.m.

Institution of Automobile Engineers: North of England Centre.—Milton Hall, 244, Deansgate, Manchester. Paper, "Experiments on a High-speed Gas Engine," by Mr. A. F. Burstall. 6.30 p.m.

Institution of Civil Engineers.—Great George-street, Westminster, London, S.W. 1. Joint meeting with the Institution of Mechanical Engineers, the Institution of Electrical Engineers, the Institution of Naval Architects, the Institute of Marine Engineers, the North-East Coast Institution of Engineers and Shipbuilders, the Institution of Engineers and Shipbuilders in Scotland, the Institute of Chemistry of Great Britain and Ireland, the Institution of Gas Engineers, the British Electrical and Allied Manufacturers' Association, the British Engineers' Association, which are co-operating in the work of the Special Committee on Tabulating the Results of Heat-engine Trials. "A Standard Code for Tabulating the Results of a Steam-generating Plant Trial," by Mr. W. H. Patchell. 6 p.m.

North-East Coast Institution of Engineers and Shipbuilders: Graduate Section.—Bolbec Hall, Newcastle-upon-Tyne. Paper, "The Possible Influence of Recent Research on Propeller Design," by Mr. J. Calderwood. 7.15 p.m.

Royal Microscopical Society: Industrial Applications Section.—20, Hanover-square, London, W. 1. Lecture, "The Making of Microscopical Preparations—(2) Imbedding and Section Cutting," by Dr. J. A. Murray. Papers, "The Microscopical Investigation of Fungal Attacks on Wood," by Professor P. Groom; and "The Application of Microscopy to the Photographic Industry," by Messrs. A. P. H. Trevelli and R. P. Loveland. 7.30 p.m.

Women's Electrical Association.—Morley Hall, 26, George-street, Hanover-square, London, W. 1. Lecture, "The All-electric Home," by Miss M. Partridge. 3 p.m.

THURSDAY, MARCH 26TH.

Institution of Automobile Engineers.—Training School of Vauxhall Motors, Limited, Luton. Luton Graduates' meeting. Paper. "Maximum Performance and Balance of a Four-cylinder Engine," by Mr. Gibson. 7.30 p.m.

Institution of Locomotive Engineers.—The Engineers' Club, Coventry-street, London, W. 1. Annual general meeting. Paper, "Special Machine Tools for Locomotive Work," by Mr. M. Lewis. 7 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, London, W. 1. "Chemical and Physical Effects of Light—I.," by Mr. T. Thorne Baker. 5.15 p.m.

FRIDAY, MARCH 27TH.

Institute of Marine Engineers.—85-88, The Minories, Tower-hill, London, E. 1. Annual meeting. 6.30 p.m.

Institution of Civil Engineers: Birmingham and District Association.—Chamber of Commerce, New-street, Birmingham. Institution lecture, "The Constructional Engineering of Aircraft," by Mr. R. K. Pierson. 5.30 p.m.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Informal meeting. Discussion on "The Cutting of Heavy Steel Sections." 7 p.m.

Institution of Municipal and County Engineers.—Holborn Restaurant, London, W.C. 1. South-Eastern District meeting, followed by annual dinner. 4.30 p.m.

Institution of Municipal and County Engineers.—The Council House, Smethwick, Birmingham. West Midland District meeting. 2 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecturette, "Irrigation Engineering in Burma," by Mr. A. P. Morris. 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—Literary and Philosophical Society's Rooms, Newcastle-upon-Tyne. Lecture, "Conversion of the ss. Bintang," by Engineer-Lieutenant-Commander L. J. le Mesurier. 7.30 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, London, W. 1. Discourse, "Studies of Atomic Nuclei," by Sir Ernest Rutherford. 9 p.m.

SATURDAY, MARCH 28TH.

Borough Polytechnic Institute.—Borough-road, London, S.E. 1. Annual exhibition of Students' Work. 6 p.m.

Institute of British Foundrymen: Lancashire Branch, Junior Section.—Visit to the works of Linotype and Machinery, Ld., at Broadheath, Altrincham, near Manchester. 3 p.m.

Institution of Automobile Engineers. — London Graduates' visit to the works of the Vacuum Oil Company, Limited, York-road, Wandsworth. 2.30 p.m.

Institution of Civil Engineers.—Students' visit to the works of the British Electric Transformer Company, Ld., Hayes, Middlesex.

Institution of Municipal and County Engineers.—Yorkshire District meeting at Doncaster. 11 a.m.

MONDAY, MARCH 30TH.

Institution of Mechanical Engineers.—Storey's-gate, London, S.W. 1. Graduates' Section meeting. Informal discussion on "Road *v.* Rail Transport." 7 p.m.

Junior Institution of Engineers: North-Western Section.—Manchester Geographical Society's Rooms, 16, St. Mary's Parsonage, Manchester. Informal meeting and election of new chairman. 7.15 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

We are informed that Messrs. G. M. Clark and Partner have opened offices at 7, Victoria-street, Westminster, S.W. 1, where they propose to act as consulting engineers.

Andrew Barclay, Sons and Co., Ld., of Caledonia Works, Kilmarnock, desire to state that they have no connection with Barclay and Co., Ld., of John Finnie-street, Kilmarnock, now in liquidation.

G. W. Brown, A.M.I. Mech. E., asks us to announce that he is giving up business in Belfast as engineer and agent to rejoin F. Wigglesworth and Co., Ld., Clutch Works, Shipley, as works manager, and requests that all correspondence should, on and after April 1st, be sent to him to the latter address.

The Council of the Royal Aëronautical Society announces that it has received Colonel Lockwood Marsh's resignation of the position of secretary. After full consideration it feels that it has no option but to accept this resignation, which it does with very great regret. At its request Colonel Lockwood Marsh has agreed to postpone the coming into effect of his resignation to May 1st.

Fuller's United Electric Works, Ld., of Chadwell Heath, Essex, asks us to state that it has removed its London depôt from 58, High-street, W.C. 2, to more commodious premises at Sparta House, 176, Tottenham Court-road, W. 1. Telephone number, Museum 9008–9009; telegraphic address, "Fullasparta, London." It also notifies us that its Leeds agent, Mr. F. Dawson, has moved his offices to 7, Park-square.

Marshall, Sons and Co., Ld., of Gainsborough, inform us that Mr. W. F. Weston, whose address is 346, Foxhall-road, Ipswich, has been appointed to act as their representative in the counties of Norfolk, Suffolk, Essex, Hunts., Beds., Herts., and Cambs. He will deal with industrial power plant only, including "Marshall" oil engines, "Locomobile" steam engines, and other types of engines and boilers.

Mr. R. W. Weekes, of Maxwell House, Arundel-street, Strand, W.C. 2, informs us that, for reasons of health, he has decided to dispose of his consulting engineering practice to Mr. W. J. Hudson, who has been his chief assistant since 1919, and who will continue the practice under the style and title of Weekes and Hudson at the above address. We understand that Mr. Weekes, after a holiday, will specialise in arbitration work in technical cases, and that then his advice will be obtainable by his old clients through the new firm.

A War Department Motor Van.—The War Office has published a complete specification for a pneumatic-tired chassis suitable for 15-cwt. van and four-stretcher ambulance bodies. This chassis is not the subject of a War Department subsidy, but it is of interest to the general public in that the specification calls for a strongly built vehicle comparable in performance and, to some extent, in constructional detail, with the subsidy type pneumatic tired light lorry. It differs but little from the 20–25-cwt. British-built commercial vehicle, and the principal features of the specification are those referring to cooling clearance, hill climbing and brake power, all of which should be of value to the commercial motor vehicle owner in hilly districts at home and to the colonial user abroad.